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CIVIL ENGINEERING

Published by the American Society of Civil Engineers

FIRST OF A SERIES OF IMPROVEMENTS PLANNED TO RELIEVE TRAFFIC CONGESTION IN PITTSBURGH'S GOLDEN TRIANGLE
New Water Street Project, to Be Completed This Fall, Will Replace a 35-Ft Pavement with a Modern Highway of Ten Lanes

Volume 10 — *Number 9*

SEPTEMBER 1940

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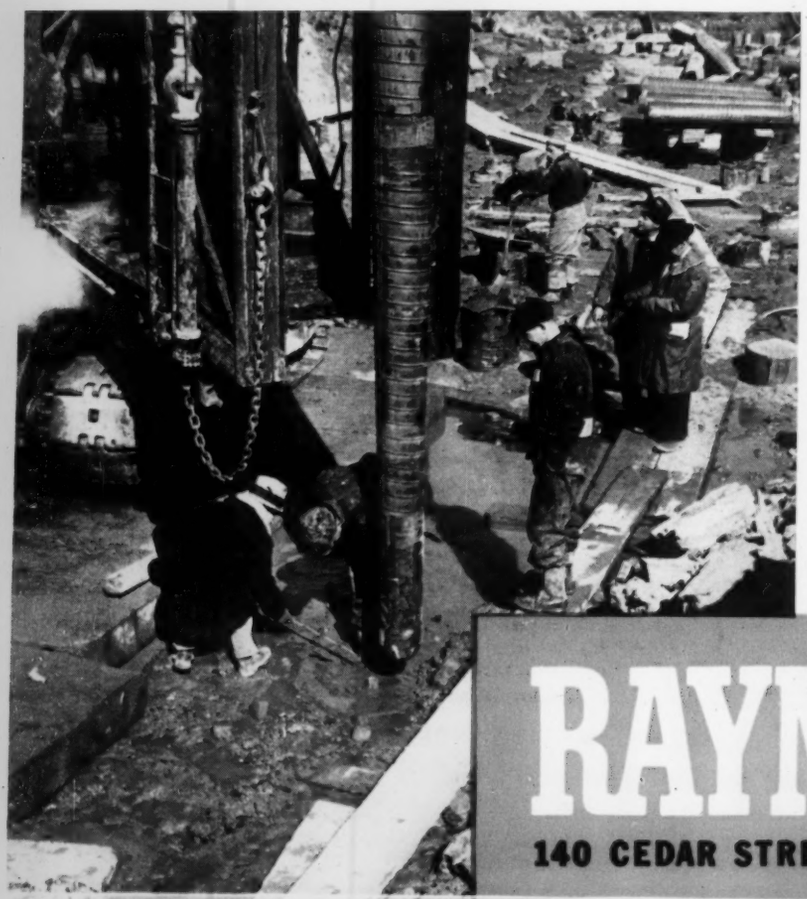

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Among Our Writers

T. R. Agg (Iowa State College, '05) has been teaching at his alma mater since 1913 and has been dean of engineering since 1932. Highway engineering is his field of special interest. He is currently president of the Iowa Engineering Society and is now in his third year as Director, Am. Soc. C.E.

John W. Cowper, after 27 years of construction experience in the U.S. and England, organized in 1915 the engineering and contracting company of which he is president. He is a charter member of A.R.E.A., an organizer, director, and past-president of the A.G.C., and is now chairman of the Construction Division, Am. Soc. C.E.

Harry O. Locher (V.P.I.), 38 years in construction work, has built levees on the Mississippi, tunnels in the Far West, and hydro plants and subways in New York; and has had wide experience in purchasing and installing construction equipment and selecting and organizing personnel. He is secretary of the Construction Division, Am. Soc. C.E.

R. E. Lawrence (U. of Kans., '25) has been with Black & Veatch since 1937. Previously he had served as state director, in Kansas, for the PWA, and still earlier as associate engineer of the Kansas State Board of Health and assistant professor of civil engineering at the U. of Kans.

N. M. Newmark (Rutgers, '30) has been on the staff of the University of Illinois Experiment Station since 1934. Since 1936 he has been engaged, with others, on a cooperative investigation of reinforced concrete bridge slabs, sponsored by the Public Roads Administration and the Illinois Division of Highways.

H. S. Tullock's work over a considerable period of years has been largely executive. For some twenty years he has been president of the Missouri Valley Bridge and Iron Company.

C. D. Vail (U. of Ill., '91) was manager of parks and improvements, City and County of Denver, for 7 years before becoming State Highway Engineer of Colorado in 1930. Earlier work included railway and hydraulic engineering throughout the West and 6 years as engineer, Public Utilities Corp., State of Colorado.

L. B. Roberts has been on mapping expeditions in Ethiopia, Chile, and Mongolia, and is author of a text on topographic mapping. He was with the 29th Engineers, A.E.F., in grades from second lieutenant to major, and served on the construction of the New York World's Fair as assistant chief engineer.

M. O. Sylliaasen (U. of Wash., '13) was city engineer of Seattle, 1932–1934, and has since conducted his consulting practice in that city. Previous work included two years of general contracting in Memphis and 15 years on design of large buildings of all types in the Northwest.

Daniel R. Neff (Carnegie Tech., '21) spent several years as a mining engineer in the Southwest and in Ecuador, and was for a while with the Missouri State Highway Department. Since 1930 he has been with the U.S. Engineer Department in Kansas City. He is now engaged in design of river control structures and in safety promotion.

L. P. Hatch, after two years of miscellaneous sanitary engineering work, was for five years a research fellow at Harvard, investigating the fundamentals of fluid flow through packed columns. In the past four years, with TVA, his duties have included evaluation of occupational disease hazards and design of control systems.

O. N. Floyd (U. of Tenn., 1905) is frequently employed by contracting firms to help prepare bids on large dams and to advise on construction plant and operation. He is a consultant for TVA, and for the U.S. Army Engineers on Sardis, Wappapello, and other dams. From 1911 to 1922 he was with Morgan Engineering Co., most of the time on Miami Conservancy District work. Since then he has been mainly in private practice.

William S. Walker (M.S. in C.E., Carnegie Tech., '35) took most of his college work at night, while holding various engineering positions. Before his engagement with Pittsburgh's chamber of commerce he had been with its department of public works and its planning commission, and with the state highway department and the U.S. Engineer Office.

Volume 10 Number 9

September 1940

Entered as second-class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1102, Act of October 3, 1917, authorized on July 5, 1918.

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CIVIL ENGINEERING

Published Monthly by the

American Society of Civil Engineers
(*Founded November 5, 1852*)

Publication Office: 20th and Northampton Streets, Easton, Pa.
Editorial and Advertising Departments:
33 West 39th Street, New York

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Subscription Rates

Price 50 cents a copy; $5.00 a year in advance; $4.00 a year to members and to libraries; and $2.50 a year to members of Student Chapters. Canadian postage 75 cents and foreign postage $1.50 additional.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Freedom to "Talk Back"

Open Discussion in "Proceedings" to Be Tempered with Logical Principles

By T. R. Agg, M. Am. Soc. C.E.
Chairman of the Society's Committee on Publications

SOCIETY publications are an open forum in which potentially sixteen thousand engineers may argue. To keep the record straight, certain forensic rules, not always understood by the debaters, are established by the Committee on Publications. In order that moot questions may be clarified, the Committee has authorized this statement by its chairman.

ONE of the most precious rights of the United States citizen is his liberty to speak his mind. In his exercise of this right the civil engineer has an agency organized, not only to defend his privilege as applied to opinion in the civil engineering field, but to encourage him to exercise it. That agency is the Society's Transactions. So important is this liberty to the central purpose of the Society that free and full discussion of technical papers in Proceedings is a constant concern of the Committee on Publications.

Guidance Needed.—Like every other privilege in a democracy, the right of discussion is limited by principles of expediency and by financial restrictions. In fairness to all discussers alike and for guidance of the editors, the Committee has had to establish certain rules.

It is only natural perhaps that these principles sometimes appear to contributors as unreasonable restrictions, as an attempt to hamper or throttle the free flow of valuable ideas. An author is usually convinced—and rightly so—that his thoughts are important, even indispensable. The Committee's concern is frequently not so much with the value of the discussion, which is usually taken for granted, as it is with its applicability. The ideas here outlined, therefore, are intended to throw light on the principles and reasoning on and around which the policies of the Committee on Publications have been developed over many years.

Discussion Is Open.—An original paper, in Proceedings, is the expression of the opinion of a single person—the author. If the official final publication in Transactions, with all discussion and closing discussion, fails to record the mass opinion of all qualified persons in the entire membership, it is the fault of all those members who missed their opportunity to "talk back."

Herein lies a distinction between these two publications that often is not appreciated by the busy member, who is apt to conclude that Transactions is merely a second printing of Society papers. But it is more than that—Transactions could not exist without Proceedings. What is still more, Transactions, the final objective to which all the preceding steps lead, is the only excuse for the existence of Proceedings.

The essential distinction lies in this very item of discussion. As its name implies, Proceedings is a publication that is alive and developing. This advancement is largely by discussion. Only as discussion is free and apropos can an idea presented in Proceedings be considered as crystallized into accepted engineering thought. Then it is complete, and then only can it qualify as a part of Transactions—something that has been finished.

A Duty as Well as a Privilege.—When a paper reaches Transactions, therefore, every reader has a right to assume that all dissenters have recorded the basis of their dissent and that therefore the final product contains the ingredients for determining what Society members (young and old) think about the subject under discussion. Doubtless this privilege is sometimes disregarded. A member qualified to discuss or criticize may be busy, or bashful, or oversensitive to the fear that someone may think he is trying to "break into print." Perhaps personal considerations may dissuade; even his em-

ployer may frown on it for purely commercial reasons, possibly fearful of some untoward effect or "comeback."

But the fact remains that discussion is more than a privilege—it is a duty, to the Society and to the profession as well. Furthermore, each member on joining the Society undertakes to give the profession the benefit of his technical knowledge. All these factors and, in fact, every consideration tend to encourage the widest discussion.

Room at a Premium.—Since many members and some non-members recognize this duty, hundreds of discussions are received by the Society yearly. The number tends to increase. In order to make the necessary room, the Committee on Publications has continuously endeavored to condense papers. In this way, while less room is allotted to papers, at the same time more papers can be accommodated. But added papers only increase the number of discussions, tending to nullify the saving, so that even with more room available, the relative demand for space for discussions continues unabated. And they are most welcome!

But it is inevitable that some of these come short of the high standards set for printed comments, in the same way that many a submitted paper fails to measure up to the necessary standards for acceptance. That is, in spite of the desirability of discussion, a contribution occasionally does not qualify—it has to be modified by the writer, or else declined.

A Positive Standard.—What, then, is the answer to the occasionally disgruntled contributor who feels that his discussion has been unjustly rejected or edited—that is, "censored"?

To avoid a negative emphasis, it may be stated that the Society always prints a discussion in which it is apparent that the writer sincerely desires to assist the profession in appraising the paper under discussion. This does not mean that he may dismiss the general subject, and instead write what amounts in effect to an addition to the main paper. The selection of "main paper" material is a task for which the Committee on Publications assumes sole responsibility, and considerable time is spent reviewing the appraisals of experts before it decides to allot a definite space to a definite subject.

Guiding Policies Are Simple.—From time to time the Committee has taken pains to explain, by articles in CIVIL ENGINEERING, its aims as applied to discussers. The cardinal principles may be summarized as follows:

1. The contributor must write in the form of a discusser and not of an author. If his contribution deals with a method to displace the one under discussion (the argument being that his "method" is superior), it should be presented for consideration as a separate paper. The discusser must honor the scope of discussion as defined by the original paper—in other words, he must stay within the same limitations of subject matter as those to which the author confined himself.

Obviously the Committee would hesitate to accept a main paper treating a subject already under discussion, at least until after considerable intervening time had elapsed, if at all. Therefore it usually proves advisable to adjust worthwhile ideas as a discussion of a current paper rather than to hold them for the doubtful possibility of later use in an independent manuscript.

2. Discussers must be neutral—they may not deal in personalities. That is, they may not discuss the person of an author—or any other person, for that matter—but only the paper itself. Even allusions that might be construed as belittling to any engineer are taboo. Criticism must rest on a technical foundation rather than on any question of personal ability.

3. Editors are instructed to minimize or delete material readily available elsewhere, including quotations. A discusser's original views are probably valuable; some one else's opinions, especially if they are already in print, can be omitted. This is a matter of simple economy. In addition, it is a question of appearance, since excessive quoted material, required to be printed in solid format, creates an unpleasant reaction in the reader.

4. Contributors may not advocate special interests, in an advertising sense, or seem to do so. Unless the discussion is objective, is analytical without appearing critical, and is disinterested, it falls under the weight of its own character. Furthermore, the Society cannot afford to give publicity to any views that smack of commercialism.

Eyes on the Main Issue.—What, then, is the guiding principle by which the discusser may gage in advance the validity of his discussion? Basically, he must attune his contribution explicitly to the author's contentions, arguments, proofs, and data. No matter how valuable the contributor's views on the same general subject, they do not rate publication unless they are related immediately and by reference to stated parts of the original paper. These same relationships hold in ordinary parliamentary procedure. In other words, the primary objective is not to collect all possible views no matter how worthy, but to reinforce, disprove, or clarify the author's thesis—that is the "subject before the house" and that only is open for comment.

This is a society of civil engineers and as such it may legitimately disseminate material relating directly or broadly to that profession. Any statement that borders on the personal has no place in a technical paper. Similarly the TRANSACTIONS cannot be considered by any stretch of the imagination as suitable for the dissemination of political or social philosophies.

Discussion to Be Tied In.—This does not mean to say that experiences or deductions parallel or similar to those in the paper are ipso facto ruled out of discussion. But it does mean that such auxiliary matters must be obviously and directly related, by specific reference, to the original. The Committee is liberal in interpreting this requirement, while at the same time it is adamant in insisting that the principle is rational and proper.

The reasons for the foregoing must be self-evident. There are other, more or less minor, considerations; but what has been said will indicate a consistent determination on the part of the Committee on Publications to administer its allotted funds with the greatest possible prudence, and to select, with discriminating care, the best there is in the overwhelming mass of written material available. The attitude toward discussers is a liberal one because discussion is acutely essential to the life of PROCEEDINGS and to the principle that, in this place at least, the civil engineer is accorded his long-standing privilege—a free right to "talk back."

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CIVIL ENGINEERING

SEPTEMBER 1940

VOLUME 10

NUMBER 9

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Safety Pays Dividends

Cost of Carelessness on Construction Runs High for Both Contractor and Worker

By JOHN W. COWPER, M. AM. SOC. C.E.
PRESIDENT, THE JOHN W. COWPER COMPANY, INC., BUFFALO, N.Y.
and HARRY O. LOCHER, M. AM. SOC. C.E.
SECRETARY-TREASURER, THE NATIONAL ASSOCIATION OF RIVER AND HARBOR CONTRACTORS, NEW YORK, N.Y.

TWO first-line battleships would cost no more than the injuries sustained by construction workers in a single year. And at least 95% of all these accidents are due to carelessness, say Messrs. Cowper and Locher. Since "talking about accident prevention doesn't impress most of us," they talk mostly about actual accidents instead—"accidents that should not have occurred." Their article should be on the "must" list of every construction man, from gang foreman to chief engineer.

FROM ancient times to the present, an amazing evolution in construction, design, materials, and methods, has taken place. Skyscrapers, tunnels, caissons, dams, bridges of long span and great height—all these have made it necessary to introduce highly mechanized equipment for rapid and economical erection. All changes have brought about greater hazards to workmen, as well as to property.

Has safety in construction kept pace with this progress? Apparently not. And in failing to do so, construction men may be charged with negligence, lack of humaneness, and with economic waste. After many years of experience and after witnessing hundreds of accidents, from mashed hands and feet to severe maimings and fatalities, it is our considered belief that at least 95% of all accidents are due to carelessness—carelessness in safety measures, or carelessness of men in looking out for themselves. Both of these factors require thought and study. Besides the social tragedy that follows in the wake of most serious or fatal accidents, there are always economic losses, sometimes running into thousands of dollars. The cost of construction accidents is a tremendous burden. Even in 1938, a year considerably below normal in construction activity, the cost was close to $100,000,000 in losses for injuries—and this figure takes no account of the losses to the injured in time not covered by compensation, or of medical expenses, or damage to equipment and property.

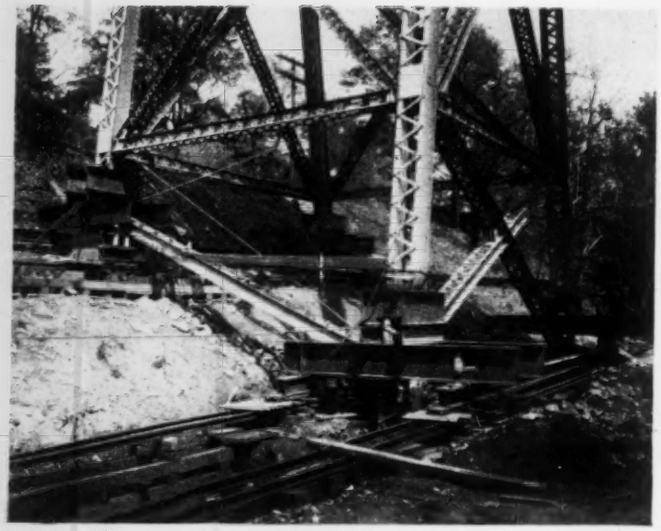
Though the accident situation is largely in the hands of superintendents, foremen, and other "outside" men in authority, the real incentive to safety measures must originate with, and be the rule of, the head officer. The head must first become safety-minded himself and pass this attitude down through his staff, all the way down, keeping it alive with unfailing vigilance. He must press it home to everyone by criticizing bad planning, and by complimenting and encouraging those under him for methods that have proved safe. The directing head should watch accident records as he watches construction costs and finance, because safety plays an important part in costs and finance. The accident record can weigh heavily in the profit and loss account—particularly in these times when competition is probably the closest ever known, and the margin of profit (if any) is extremely slim.

Any superintendent or foreman who is making a bad accident record should be investigated. The safety of his men is as much a part of his work as is how many cars they put in the dump, how many tons of steel they set, or how many yards of concrete they get in. Every foreman should be made to realize that accidents are costs—costs that sometimes make a job show a loss. Insurance is rarely complete protection, either when carried by a company or by the contractor himself. And there are lots of shocks that no amount of insurance money can heal.

Making construction work as safe as possible is, of course, the best method of preventing accidents. Again, superintendents, foremen, and mechanical men are the ones most responsible for safety measures; they should do the thinking and looking ahead.

A MOVING JOB WHERE CAREFUL TESTING OF TEMPORARY STRUCTURE AND THOROUGH DRILLING OF THE CREW PAID DIVIDENDS

Entirely Without Incident, the Old Calvert Street Bridge in Washington, D.C., Was Shifted Bodily 80 Ft to the Side, a Few Years Ago, to Make Way for a New Structure



A CLOSE-UP OF THE CALVERT STREET BRIDGE-MOVING OPERATION
Cables and Steel Rollers in Place for the Move

One of the best accident preventives is "good housekeeping," or keeping the job or project in a clean, orderly condition. Particular care should be taken not to have boards scattered about with protruding nails. These cause many accidents and, if not given immediate attention, result in serious infections. Another seemingly small matter but one that gives much trouble, is injury to the eyes. Hard, abrasive, and sharp particles getting into the eyes result in many serious and costly after-effects. In working where this danger is at all probable, protective goggles should be worn. Another hazard which has come much to the front in recent years—we have heard so much about it that it seems unnecessary to mention it more than briefly—is exposure to rock dust, which results in silicosis. In many states the laws covering silicosis are so rigid and the penalties so great in case of its development that very few insurance companies will cover the risk. Where this danger exists, all preventive measures known should be taken advantage of. Genuine silicosis is a grim reaper.

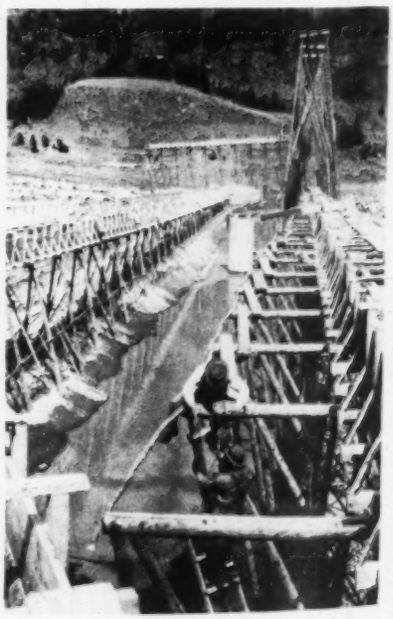
Careful and safe planning of all temporary work is highly important. A few years ago, a steel viaduct constructed in 1891, 750 ft long, 135 ft high, with a dead weight of about 1,600 tons, was moved in a parallel position a distance of 80 ft to serve as a detour while constructing a new reinforced concrete arch structure. Several weeks were consumed in planning and constructing a temporary structure on which to move this bridge, all done with the greatest care and testing. When the moving of the structure was started, about two hours were taken to move the first 5 ft, for the purpose of thoroughly organizing and drilling the moving crew in its duties. The structure was moved the other 75 ft in less than five hours, with the result that there was not even a scratched finger and, to the amazement—and disappointment—of thousands of spectators, the structure did not fall over in moving. Six and eight-story buildings have been moved without accident or injury, because of the same meticulous care in planning and organizing.

Some think that, on account of the temporary nature of a construction job, just any old safety measures, or none at all, may be all right. They are all wrong! When a contractor is doing work continuously, his business can be considered as permanent as any permanently located industrial business, and his safety measures and policies should be no different. A man killed on a contract job is just as dead as one killed in a steel mill—and his wife and youngsters will miss him just as much. Because an individual contract job is temporary is no reason whatever for not properly protecting workers. Not to do so adds to social misfortune and runs costs up to sometimes ruinous amounts.

Simply talking about accident prevention does not impress most of us. But when one sees a man maimed or killed, a vivid and lasting impression is made upon one's mind. It is not forgotten; usually a genuine resolve is made to do something about accidents, and something is done. With this thought in mind, we shall tell in detail about some accidents that should not have occurred.

On one occasion a stiff-leg derrick, with 12 by 12-in. wood back legs and sills, erected on the top of a 10-story building for use in erecting a building on adjoining property, fell because one of the wooden back legs broke. Fortunately, no one was killed, but several were hurt and considerable property damage was done. This derrick and all its parts had been carefully inspected before erection, but because of its having been painted with a heavy coat of red lead, no defects were visible, nor did the usual sounding methods of timber show any. After the timber broke, it was discovered that there was quite a serious interior rot. Although the defective area on the surface was very small, it would have been sufficient to condemn the member had it not been hidden by the coating of red paint. Lumber, particularly timbers used in temporary construction, should never be painted.

Dangerous places must be made as safe as possible—both to protect thoughtless men and to protect thoughtful men who know they are in a dangerous place and cannot give full thought to what they are doing on that account. On a certain hydraulic-fill dam, the material was sluiced to the site through wood flumes built on high trestles. The trestle and flume timber was sawed locally; it was not first-class material. In spite of careful inspection, a bad stringer would sometimes be used. Sometimes when the flume became clogged and overloaded, one or more 12-ft sections of trestle and flume would go down. Several men were severely injured by these accidents. In topping out the dam, it became necessary to build a double-deck trestle over 80 ft high, with the 3 by 3-ft flume on top of it. It was a spindling-looking structure. The flume tenders did not relish working up there, and they could not be blamed. If they happened to be on a section that went down, there was little chance of their escaping fatal injury. They were inclined to play safe and hang back toward the ends of the trestle. This increased the possibility of the



ON THIS SPINDLY DOUBLE-DECK TRESTLE FATAL ACCIDENTS MIGHT EASILY HAVE OCCURRED

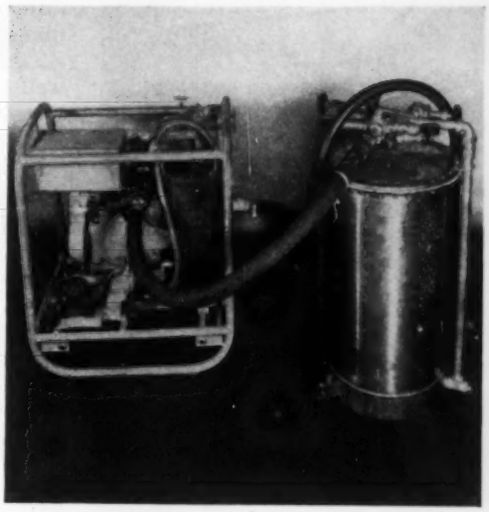
But the Chance Remark of a Workman Led to a Simple Solution at Insignificant Cost (See Text)

flume's clogging, as the men were not strung along as they should be to keep things in order. One day the superintendent heard one flume tender say to another, "If I knew this old running board would stay up, even if the trestle did go down, I wouldn't feel so skittish up here." This remark gave birth to an idea which resulted in resting the top cross-braces of the flume, and the running board and hand rail which they supported, on two $^3/_4$-in. cables suspended from high bents to each end of the trestle. This device gave the men a feeling of complete safety; they attended to their work properly and there were no further clogs or breaks.

On another job, timber lining was being removed from a tunnel that was to be relined with concrete. The wall plates were sawed at certain places and several sections of segments and lagging pulled down with a cable from a hoisting engine set several hundred feet back. One day a bad cave-in followed the falling timber, killing two men and almost blocking the tunnel to the normal roof. As the work was supposed not to interfere with traffic, the track had to be cleared as quickly as possible. However, a desultory falling of rock kept up, and the men were afraid to work under it. Finally two bulkheads of 12 by 12-in. timbers were built across each of two flat cars, one about 8 ft from the front end of the cars and the other about 16 ft back of the first. On top of these were laid 12 by 12-in. timbers about 30 ft long, projecting over the front end of the cars 6 or 7 ft. The men worked under this projection without fear, loading the stone on to the end of the car. When one was loaded, it was pulled out and the other shoved in. The fall was speedily cleaned up, no one being hurt.

A contractor's loaded truck once stalled on a railroad crossing, derailing a locomotive and part of a train. Two men were killed and large property damage resulted. The contractor was ruined. Why did this happen? Through carelessness and thoughtlessness. Where? Everywhere. The truck was overloaded. It had been sent out that morning with a motor not running smoothly. The driver knew the crossing was a dangerous one and that trains passed frequently; yet he limped up to the crossing with a sputtering motor and a big overload. No prudence had been shown anywhere from the time the truck had left the yard until it was demolished. Such is the history of many accidents—no prudence anywhere!

Superintendents and foremen must constantly keep after men to keep in the clear; to use their heads. And they must constantly seek ways to throw about them as many protective measures as possible.



A PURE WATER PLANT FOR CONSTRUCTION JOBS
An Adequate Supply of Good Water Is as Much a Factor in Construction Safety as Are Safeguards Against Physical Injury

THE MISSING FISH-PLATE BOLT

Taking foolish chances causes many entirely unnecessary accidents. Nothing was ever more true than "haste makes waste." A locomotive crane was being moved across a partly filled canal on a temporary fill. There was about 8 ft of water on each side of it. Three 20-in. dredge pipes, buried about 3 ft, passed through the fill. For moving, 12-ft lengths of rails were spiked to 8 by 12-in. timbers, and overlapped them a foot or so at the forward end, to make the joint. Before moving up, the joints were made secure with fish plates with a bolt in each rail. When the crane was near the center of the fill and ready to make a move, a fish-plate bolt rolled down the bank into the water. It happened that there were no extra ones on the machine. (Detail!) "We'll take a chance," said the foreman to the runner, "Try her." He did. When the front truck hit the joint with a bolt on only one side of it, instead of going over the joint, it shoved this rail and timber ahead out of place. The truck dropped down into the soft fill and on down through the dredge pipes. In about 30 seconds the crane was lying on its side in the mud and water, half out of sight—all on account of not having one $^3/_4$ by $3^1/_2$-in. bolt. Too much hurry costs money almost every time. Usually, too, tragedy follows in its wake.

On another occasion a $2^1/_2$-yd railroad-type shovel had been rigged as a dragline with a 60-ft boom, to do bank sloping on a canal job. It worked from a track laid along the canal. On windy days, it was difficult to keep the boom from whipping around—the swinging mechanism was not designed for 60-ft booms. Provided the jacks were set, there was no particular danger if the boom did get away. As a safety measure, when moving, the bucket was ordinarly left on the ground with the hoist line kept taut until the move was completed and jacks reset. One morning the shovel had to be moved across a 60-ft trestle about 12 ft high, which crossed a stream flowing into the canal. A stiff wind was blowing against the front of the machine. A move placed the shovel fully on the trestle. When ready to move back, instead of leaving the bucket on the ground straight out in front and playing out the drag and hoist lines, the operator picked up the bucket and started to move. With the jacks up and the bucket in the air, a gust of wind hit the boom; the operator could not hold it; he lost his head and forgot to drop the bucket. In a few seconds, the boom had swung around far enough to upset the shovel into the creek below, badly damaging it and seriously injuring and scalding the operator. For some unknown reason he "took a chance" and lost!

This is a strange quirk in some men—they have a sort of urge to "take a chance." The trait is sometimes found in the most capable men. But too often it causes serious or fatal accidents and costs a lot of money. Men who take chances on losing weeks and thousands of dollars, in trying to save a few hours and a few dollars, should be stepped on. The odds are stacked high against them. If they win, it isn't much; if they lose, it may be calamitous. Such procedure is almost always bad judgment, paid for with social tragedy and money that could have been saved.

Timber was being unloaded from a work train along the main line. Everybody was in a hurry; the timber was shoved off, "any old way," to get rid of it quickly, and as long as it cleared the work train it was left where it fell. One morning, after several cars had been unloaded and the work train moved out, the foreman stood on the pile trying to make a record of it. A through train passed and the end of a wide car struck a projecting 12 by 12. In a flash, the foreman was in the midst of a moving, twisting pile of heavy timbers. He was maimed for life. Orderliness and care in piling the timber, or care by the

PICTORIAL REMINDERS LIKE THESE NATIONAL SAFETY COUNCIL POSTERS PLAY A BIG PART IN REDUCING ACCIDENTS ON CONSTRUCTION

foreman in keeping back out of such possible danger, would have prevented this accident. Once again: It is a safe statement that thoughtlessness is the cause of most accidents.

Six-yard skips, loaded with stone, were being unloaded from railroad cars by a cableway which passed over the track. A foreman, a bright and usually alert man, stood between the skip to be hoisted and the one next to it. He failed to notice that the hooked-up skip was not plumb with the cableway carriage overhead. He gave the signal to hoist. As the heavy skip cleared the floor of the car, it swing plumb and crushed him to death against the adjoining skip. Another usually clear-headed foreman instructed several men to put a long heavy chain around a 3-yd stone to be hoisted out of an excavation. When the big stone was 4 or 5 ft in the air, the chain slipped off and the 20-lb hook, like the cracker on the end of a whip, struck the foreman on the head, killing him instantly. He should have stood back several feet farther than the chain was long. It had often slipped off before.

As thoughtlessness causes most accidents, men should be taught to think. Then too, alert, clear-headed men should think for those under them. Some men have the "feel" of danger; some do not. There are many men who always seem to step into trouble rather than away from it. The way should be made as safe as possible for them in both directions—that is, make dangerous places as safe as possible, and make it easy to get away if something starts to go. It should be remembered that men react differently and that certain men are not fit for certain places. "Put him somewhere else," a tunnel foreman told a superintendent, about an apparently ill-fated man. "I can't spend all my time keeping that fellow from killing himself." The man was put on outside work and got along all right.

"I consider it a black mark against me when one of my men gets hurt," this same foreman said. Here really is the crux of the accident situation. When the men in charge of other men and responsible for their welfare consider an accident a reflection upon them—unless they are entirely blameless—one is as near to an accident-proof job as it is possible to be. Thoughtful men must provide safety measures for, and look out for men who are less thoughtful, or who cannot be thinking about their safety all the time. Make them feel safe; first, it is laudable humaneness, and second, it is a good investment.

On large work, it is desirable to have a well-equipped clinic for first-aid treatment, with a qualified nurse or a doctor in charge; and every accident, no matter how minor, should be treated and observed until entirely cured. On a project with a payroll of about $400,000 the medical cost per case was reduced in this manner from $13.87 to $7.66; and the total cost of 596 cases treated (including compensation, medical attention, and legal costs) was reduced to an average of $24.55 per accident from a previous cost, without clinic, of $63.00.

In addition to the saving in cost, there is a saving to the employee in the matter of lost time and consequent loss of wages, due to accidents. Out of 596 cases, there were only 50 cases of lost time, the average cost of which was only $148 each. After all, the employee is probably the greatest loser because, under even the most liberal laws, he loses a week with no pay and, after the pay starts, the maximum he can receive is two-thirds of his average wage.

The cost of compensation, in accident insurance, is high. On construction it averages fully 10% on the payrolls, and in some cases (such as steel erection) it is 53%. Good records are rewarded by a reduction in this rate, whereas bad records result in a penalty. One large construction company, over a period of five years, reduced its insurance cost from an 11% penalty on the base rate to a 35% credit and, in the year 1939, on the amount of work done, this resulted in a saving in the insurance premium of over $40,000, or about 1% on the gross amount of work done in that year. Probably a like amount was saved to the employees in the difference between their full-time wages and what they might have received in compensation if they had had an accident—to say nothing of the saving in the suffering of the injured.

One of the authors, the head of his organization, makes it his duty to see personally that accident prevention is watched carefully. He insists that every accident report shall cross his desk, and whenever a report reveals carelessness or unsafe practices he personally corrects those at fault. The psychological effect of this is great; every employee knows that the "old man" is watching this particular phase of the work as carefully as he watches other things that might seem to be more important. He has found that this method is one of the best accident prevention measures, and has proved that it is highly profitable.

We repeat, if the head of the organization is watchful and makes it known to all employees that "Safety First" is no catch phrase but a solemn order to be constantly observed, much can be accomplished in accident prevention and saving of life. We believe that the safety question is one that supervising engineers should take into consideration, not in a small or petty way but as a major matter of policy. They should help wholeheartedly in seeing that safety measures are carried out on their work. We earnestly emphasize the importance of accident prevention both from the economical standpoint and the humane one. Let us plan to save men, for themselves and their families; let us protect their earning power; in short, let us plan to salvage more out of the huge cost and tragedy of construction accidents.

A New Water Supply for Wichita, Kans.

Shallow Wells Abandoned in Favor of a More Potable Source

By R. E. LAWRENCE

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ASSOCIATE ENGINEER, BLACK AND VEATCH, KANSAS CITY, MO.

TWENTY-FIVE deep wells and 33 miles of pipe line, just finished, provide a complete new water supply for the city of Wichita, Kans. Mr. Lawrence here describes the extensive program of exploration that preceded the final locating of the wells, and discusses briefly the design of the wells themselves and the results of the pumping tests. The article is an abridgment of his paper presented before the Sanitary Engineering Division at the 1940 Spring Meeting of the Society in Kansas City.

UNLIKE most water supply developments of recent years the new supply for the city of Wichita, Kans., is not required to relieve a water shortage. On the contrary, the city is abandoning an abundant supply which is cheaply produced, in favor of a less mineralized and more potable source.

The present supply is taken from a group of shallow wells penetrating the underflow of the Arkansas and Little Arkansas rivers. This water is free from turbidity, but its chemical quality reflects in general the chemical quality of the water in the Arkansas River. As shown by the following data from analyses over a 10-year period, it is highly mineralized and contains excessive quantities of chlorides:

HARDNESS, PPM			CHLORIDES,	TOTAL
Total	Carbonate	Non-Carbonate	PPM	SOLIDS, PPM
373	182	165	426	1,235
to	to	to	to	to
475	210	271	630	1,603

The concern that both the city and the water company have felt for many years regarding the quality of the supply is reflected in the ordinance granting the current franchise to the Wichita Water Company. Section 7 of this ordinance provides as follows: "Should the City of Wichita hereafter elect to develop a softer, more satisfactory water supply and to pipe the same to the plant of the Grantee, then the Grantee shall distribute said supply . . . reserving so much of its present well system for emergency use as may be advisable and necessary."

The present project for the development of a softer and more potable supply from the Equus Beds has been under consideration for a number of years. These beds, covering an area of approximately 1,000 sq miles (Fig. 1*a*), are known to be a remarkable aquifer, and have already been utilized by a number of municipalities. The strata composing them are alternating layers of sand and clay, underlain by a heavy layer of gravel which everywhere contains an abundance of water.

Rainfall over the area averages about 30 in. per year, the slope of the surface is relatively flat, and much of the area presents favorable conditions for recharge. All these facts led to the conclusion that the beds could be developed to produce enough water to serve the future requirements of the city of Wichita. Before undertaking such a project, however, it was necessary to ascertain among other things the following:

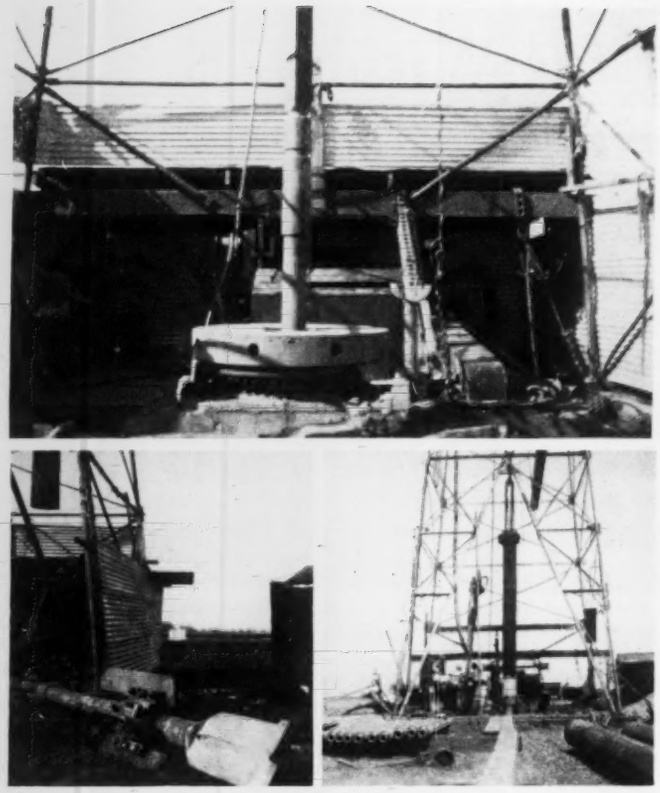
1. The most advantageous points at which to develop an extensive supply of the required quantity and quality.
2. The direction and rate of ground-water movement.
3. The effect of the Little Arkansas River on the ground-water table.
4. The degree and extent to which the depression of the ground-water table in the Equus Bed area may cause encroachment from Arkansas River underflow.
5. The effect of other possible contaminating influences, including possible contaminations by salt water from the Burrton oil field.

In 1937, a detailed investigation of the Equus Bed area was started by the U.S. Geological Survey, the Kansas Geological Survey, and the Kansas Board of Health. The first work consisted of the periodical measurement of depth to water level in several wells, and the measurement, at least once, of several hundred wells, for the purpose of constructing a water-table contour map. Early in 1938 the scope of the investigation was increased and the city of Wichita appropriated funds to match those of the other cooperating agencies. In July 1938 contracts were awarded for a number of cable-tool test wells, and this work was started under the supervision of field representatives of the U.S.G.S.

In July 1938, also, the city of Wichita filed with the Public Works Administration an application for a grant to aid in the development of a new water supply and the construction of the necessary pipe lines and appurtenant structures to convey the water to the city. The estimated cost of the project was $2,425,000, of which $1,091,250 was requested from the PWA by way of grant. With the filing of this application it was possible to plan the investigational work of the U.S.G.S. in order to cover first the area from which it was proposed to develop the new city supply. In the course of these investigations a total of 19 cable-tool test wells were constructed, and some 84 driven test wells completed.

The cable-tool wells were cased full depth, and the thickness of each stratum was carefully logged. Samples of the material penetrated were preserved for mechanical analysis. In order to secure accurate water samples from the various formations, a pneumatic packer was devised which could be inserted between the well casing and an inner pump line, to permit sampling at any depth as the drilling progressed. All samples were analyzed by the Water and Sewage Laboratory of the Kansas Board of Health. After the cable-tool wells had been drilled full depth to shale,

THE ROTARY TEST RIG



ROTARY DRILLING EQUIPMENT FOR THE MAIN SUPPLY WELLS
Top and Lower Right, General Views of the Rig; Lower Left, the Rotary Bit and Reamer

the casings were withdrawn and from one to three $1^1/_4$-in. pipes were left in place to various depths to serve as observation wells and to permit periodic sampling.

In September 1938, the city's application for a grant was approved by the PWA. As a condition of the grant, it was necessary that work on the project be started by November 18 of that year and completed by May 18, 1940. It was also necessary that the city present proof and secure prior approval of the adequacy of the proposed new water supply from the standpoint of quantity and quality.

FORTY ROTARY TEST WELLS DRILLED

In order to supplement the exploratory work already in progress, a construction contract under the PWA project was awarded for test drilling. Under this contract 40 rotary test wells were drilled at prospective permanent well locations. The data obtained from the rotary drilling, while perhaps not as accurate as that obtained from the cable-tool wells, made it possible to log the formations accurately and to secure samples of the various sand and gravel formations for mechanical analysis. The principal advantage of the rotary testing was the speed with which the test wells could be completed.

Logs of the various wells show that the water-bearing and interspersed clay formations do not occur at uniform depths. Rather it is apparent that the entire beds are of alluvial origin, with clay lenses and sand and gravel beds of varying thickness all more or less interconnected. The depth to shale varies from approximately 150 ft to approximately 260 ft, and in all test wells the static level of the ground water was within a few feet of the surface of the ground.

A water-table contour map of the area, prepared by the U.S. Geological Survey, indicates that the slope of the ground-water table is approximately 5.25 ft per mile from northwest to southeast—about the same as the slope of the ground surface. Of greater significance, however, is the fact that the Arkansas River is apparently stable under normal conditions with respect to the ground-water table. In other words, the Arkansas River under normal conditions neither drains the Equus Beds nor discharges water into them. This hypothesis was confirmed by water analyses which showed that samples from test wells immediately adjacent to the Arkansas River reflected the high total hardness and chloride content typical of the Arkansas River underflow, whereas samples from wells located a mile from the river were found to be much lower in chlorides. On the other hand, the elevation of the water in the Little Arkansas River is lower than the ground-water level immediately adjacent to the stream, indicating that the normal discharge from the beds is into the Little Arkansas.

Water samples from the various test wells indicated that the average hardness of a supply developed in that portion of the Equus Beds under consideration should not exceed 180 ppm, and the chloride content should not exceed 35 ppm. Owing to the presence of approximately one part per million of iron, however, facilities for the removal of this impurity were required.

The preliminary test drilling was not sufficiently broad in scope to indicate fully the limits of the Equus Beds; however, on the basis of the data secured, it was apparent that the area available to the well field under consideration was ample to supply the future requirements of the city of Wichita.

It has been estimated that a maximum of 30 mgd will be required by the city by 1960, and it was concluded that an initial development of this amount should be provided. Preliminary test data indicated that this amount of water could be obtained from a group of 25 wells without excessive drawdown.

SELECTING SITES FOR PERMANENT WELLS

In selecting the sites for the permanent wells (Fig. 1*b*), locations were chosen which would be far enough removed from the Arkansas River to eliminate the possibility of salt water encroachment by reason of any reversal of direction in the ground-water flow. In order to prevent a sharp depression of the ground-water table in any particular locality, a minimum distance between wells of one-half mile was maintained, and the final locations were selected after taking into consideration the economical pipe-line location, the best available formations as determined by the test drilling, and the most favorable locations from the standpoint of intercepting natural ground-water movement.

A five-acre tract was obtained by the city for each of the well sites. The agreements covering the use of the sites are in the form of permanent leases giving the city the right to maintain wells on the tracts.

The permanent water supply wells are of the gravel wall type. The specifications were drawn to permit construction either by sinking a series of large-diameter casings to full depth, or by rotary drilling. It was required that the inner well casing have a nominal inside diameter of not less than 18 in., and that the diameter of the hole at the bottom of the well be not less than 30 in. nor less than 11 in. larger than the outside diameter of the inner casing.

It was not required that rotary wells be temporarily cased to their full depth before setting the inner casing; however, it was required that a 20-ft section of outer casing be left in place at the completion of the well.

The specifications permitted the use of either concrete or metal inner casing and screen. Concrete casing and

screen was required to have a wall thickness of not less than 3 in. Metal casing was required to be not less than No. 3 gage genuine wrought iron, pure ingot iron, or cast iron. Punched or sawed screen openings in the metal casing were permitted, providing the slots were not more than $2^1/_2$ in. in length and were spaced so as not to weaken the casing. Screen openings for all types were limited in width to not less than 0.125 in. or more than 0.1875 in. It was required that the clear opening per foot of screen be not less than 25% of the area of the casing, that is, 63.6 sq in.

All gravel used for the wall around the inside casing was specified to be clean and well rounded, passing a 4-mesh screen and retained on an 8-mesh screen. A number of tests were made in the laboratory, using various sizes of gravel with various sizes and gradations of sand. It was found that smaller gravel, preferably of one size, was more effective in excluding fine particles of sand than coarser, graded material.

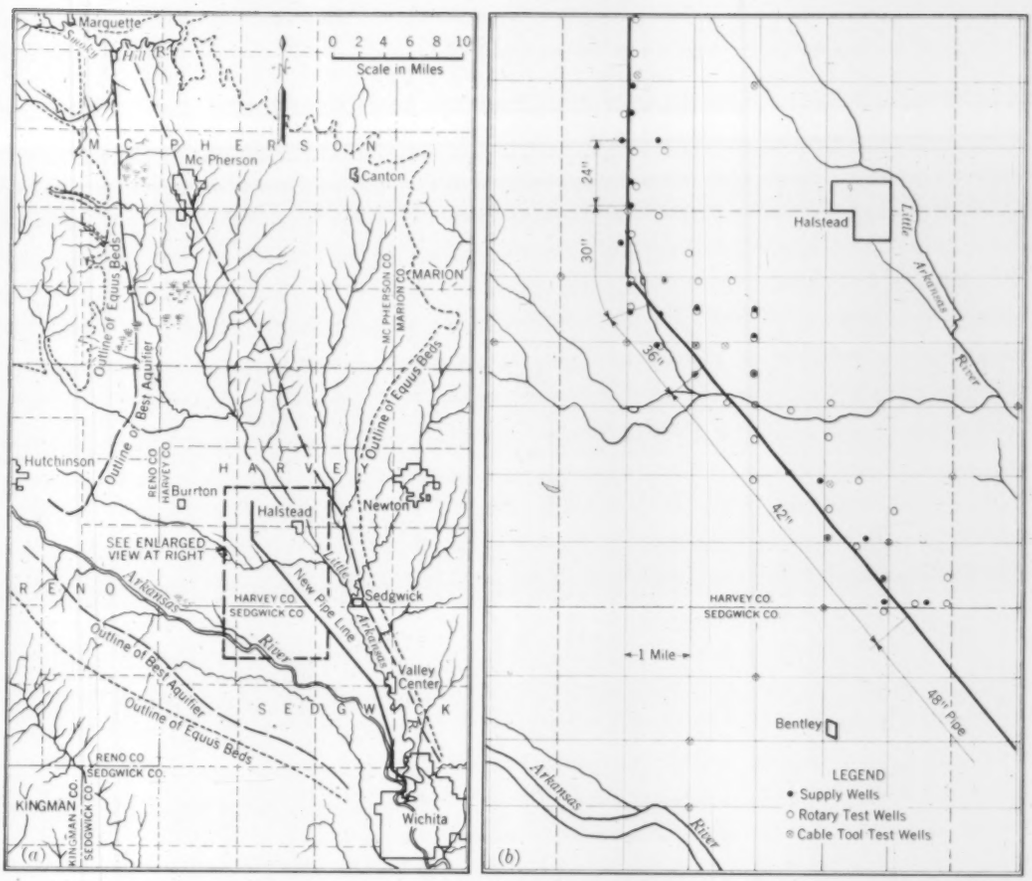
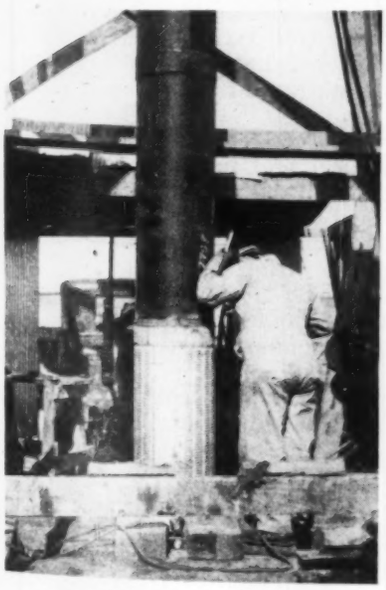


FIG. 1. LOCATION MAPS OF THE NEW WICHITA WATER SUPPLY
(*a*) Boundaries of Equus Bed Area and Route of Pipe Line; (*b*) Enlarged Portion Showing Location of Test Wells and Supply Wells

For the purpose of maintaining low entrance velocities into the well, the bids were based on furnishing screen section in the amount of 25% of the depth of the well. In most instances this provided sufficient screen opening to hold the velocity through the screen to 2 in. per sec or less. Previously it had been determined that a velocity of 2 in. per sec through the screen openings would not carry fine material into the gravel wall around the inside casing.



INSTALLING A WELL CASING AND SCREEN

To permit periodic observation of the drawdown curves, two observation wells were constructed near each water supply well—one of them about 100 ft away and the other about 500 ft. In addition, a number of observation wells were located along a general north and south line approximately 8 miles west of the well field. The purpose of these wells is to permit periodic sampling and testing to ascertain whether or not any of the brines produced in the Burrton oil field are escaping into the well-field area.

The observation wells consist of $1^1/_4$-in. standard galvanized iron pipe terminating in a farm well point 3 ft in length. The wells were installed by drilling a small rotary hole, inserting the well point and casing, and driving the point a short distance into the undisturbed water-bearing stratum. All well points were set at a depth of from 50 to 80 ft and penetrated the same water-bearing formation as the supply wells. The top of the casing was left about a foot above the ground and capped with a ventilated screw cap.

For the 25 water supply wells the contractor, the Layne-Western Company of Kansas City, used two rotary drilling machines and two casing-tool rigs. Wells less than 125 ft deep were constructed by the casing method, and the deeper ones by rotary drilling. All casing except that required for two of the shallow wells was No. 3 gage pure iron, with shutter-type screen of the same material. On two of the wells cast-iron screen and casing were used.

RESULTS OF PUMPING TESTS

As soon as each well was completed and developed so as to be free from sand and silt, a test pump was inserted and a quantity test made. An initial pumping test of sufficient duration to stabilize flow conditions at approximately 30% drawdown, or not to exceed 2,000 gpm was made, after which the pump was stopped and the water level in the well allowed to rise until a stationary

level was reached. The static water level in the well and in the observation wells was then measured, and the final pumping test started. During the final test the pump was operated continuously for 36 hours at the rate previously determined to produce a drawdown of 30%, or not to exceed 2,000 gpm. (These limits were set in order to avoid possible damage to the well during testing. In several cases the 2,000-gpm rate was reached with a drawdown substantially less than 30%.) During the progress of the test, readings were taken every 30 min to determine (*a*) the water level in the well, (*b*) the water level in the observation wells, (*c*) the rate of pumping. The following data indicate the extremes of conditions encountered:

LAYING THE 48-IN. PIPE

	Depth of Well, Ft	Static Water Depth, Ft	Test Rate, gpm	Drawdown, Ft	Drawdown, %	Specific Capacity, gpm
Deepest well	259	238.9	1,570	73.2	30.6	21.4
Shallowest well	80	67.4	1,870	20.9	31.0	89.5
Well with highest specific capacity	124	110.0	2,030	14.4	13.1	141.0
Well with lowest specific capacity	237	211.8	910	63.8	30.1	14.2

At the end of each pumping test, samples were collected for complete mineral analysis by the Water and Sewage Laboratory, Kansas Board of Health. The carbonate hardness varied from 115 to 257 ppm and the non-carbonate hardness was zero. The maximum and minimum values for each of the other items in the analysis, considering the data from all 25 wells, are shown below in parts per million:

Ca	Mg	Na	HCO_3	SO_4	Cl	NO_3	Total Solids	Fe	Mn
36	5.0	22	173	7.0	5	2.2	190	0.20	0.10
to	to	to	to	to	to	to	to	to	to
80	14.0	102	329	79.0	92	8.4	552	2.2	0.53

Most of the wells were tested at rates ranging from 1,600 to 2,000 gpm. However, in the selection of permanent pumping equipment, capacities were limited to 1,000 gpm. Twenty-three of the wells are equipped with 1,000-gpm pumps, and two with 500-gpm pumps.

The well pumps discharge through spur lines direct into the supply pipe line which conveys the water to a new filtration plant being constructed in the city of Wichita. The total length of the pipe line is approximately 33 miles, of which approximately 17.6 miles are of 48-in. pipe.

Since their completion about a year ago all wells have been regularly measured, and the city will continue to cooperate with the federal and state agencies in making periodic water-level observations. These observations, together with records of pumpage, will provide accurate data relative to the ultimate safe yield of the well field. Also, the continuing program of observation will include periodic sampling of the outpost wells adjacent to the Burrton oil field to indicate, far in advance, any possible contamination of the field by brines. As a result of conservation measures applied by the Kansas State Board of Health and the Kansas State Corporation Commission, practically all the brines produced in this field are now being returned to non-fresh water beds.

The design of the cast-iron pipe used in the pipe line was based on the principles and methods described in Part I of the "Manual for the Computation of Strength and Thickness of Cast Iron Pipe," which was approved by the American Standards Association in December 1939. It is the first installation of 48-in. centrifugally cast pipe to be manufactured under this new "law of design."

For the control of water hammer in the pipe line, automatically controlled cone and check valves are being installed in the discharge line leading from each well pump. Also, one automatically controlled cone valve, five manually operated cone valves, and two groups of angle-type pressure relief valves will be located in the pipe line. The flow of water through the pipe line will be regulated at the filtration plant by means of a float-controlled regulating cone valve.

THE FILTRATION PLANT PROVIDED MAINLY FOR THE REMOVAL OF THE 1 PPM OF IRON PRESENT IN THE WELL SUPPLY

OPERATION OF PUMPS CENTRALLY CONTROLLED

The 25 well pumps will be operated by means of supervisory control from the filtration plant. Each of them will be individually controlled, and each will give a continuous indication at the filtration plant whether on, off, or tripped. In addition to the equipment for operating all wells from the filtration plant, manual control is being provided from a control station in the well field. Manual control is also provided at each well.

One operator will be stationed at the control station in the well field who will be on duty eight hours a day, and available at other times for emergency work. This operator will daily inspect and maintain the 25 well pumps and appurtenances in the well field. A dispatching telephone system between the filtration plant, the field control station, and each of the well houses will provide direct communication with the field operator.

The filtration plant, which is provided primarily for the removal of the small amount of iron present in the well supply, will have a nominal capacity of 32 mgd. The city is also providing 4 million gal of clear-water storage at the filtration plant to supplement the existing storage of the Wichita Water Company.

Black and Veatch of Kansas City are the designing and supervising engineers for the project, which is being carried out under the supervision of Alfred MacDonald, city manager, P. L. Brockway, M. Am. Soc. C.E., city engineer, and M. E. Rogers, coordinator, for the city of Wichita. The original completion date of the project has been extended, and it is anticipated that the new system will be in operation in September 1940.

What Do We Know About Concrete Slabs?

A Concise Review of Analytical Considerations and Experimental Results

By N. M. Newmark

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THE complications of a third dimension, added to the inherent uncertainties of the interaction of steel and concrete, make the reinforced slab a fertile field for analytical and experimental research. Among those currently engaged in such studies is Professor Newmark, who here reviews the present knowledge of the subject. His full paper, of which this is an abridgment, was on the Structural Division program at the 1940 Annual Meeting, and is on file in the Engineering Societies Library.

ANY approach to the design of concrete slabs that rests entirely on empirical considerations or entirely on analytical considerations is bound to be ineffective. What we learn from experience depends upon what we seek to know. What we learn from experiment depends upon what we test. What we learn from analysis depends upon the fundamental assumptions on which our reasoning is based.

We know, or think we know, from tests, that in general the reinforcing steel will work before failure, whether we distribute it in one way or another, provided that the structure can find some way to act with the steel in the place we put it. We are sure that in certain cases the total moment on a section, or the sum of the moments on several sections, has a particular value, determined by statics. We have some reason to believe that if we provide for this total with a reasonable arrangement of reinforcing, we shall have probably as good a design as we are likely to attain by other more elaborate analyses.

However, just what is reasonable may not be readily apparent. A possible approach is through the classical methods of the theory of elasticity applied to slabs. Are such analyses applicable to slabs of reinforced concrete?

RESULTS OF ANALYSIS

Fundamental Assumptions. The ordinary theory of flexure of slabs, which is analogous to the ordinary theory of flexure of beams, is based upon the following general assumptions:

1. The principal action of the slab is in flexure, and resultant direct stresses on any section are negligible.
2. The flexural strains vary linearly through the depth of the slab, with the points of zero strain falling on a surface which may be called the neutral surface in analogy to the neutral axis of a beam.
3. Hooke's Law applies to the material; consequently the corresponding distributions of flexural stress are linear.
4. The material is homogeneous as well as elastic, and for convenience the slab is assumed to be of constant thickness and of isotropic material.

Fundamental Relations. For a homogeneous slab lying horizontally, the stresses on any vertical cross-section, as given by the ordinary theory, consist of the following:

1. Vertical shearing stresses.
2. Horizontal shearing stresses distributed linearly over the depth, having as their resultant per unit of width along the section a pure couple which is called the twisting moment.
3. Horizontal normal stresses distributed linearly over the depth, having as their resultant per unit of width along the section a pure couple which is called the bending moment, or simply the moment. Since moment per unit of width involves force times distance divided by distance, the units of distance may be canceled out and the intensity of moment at a particular point in a slab may be stated in terms of units of force only.

Obviously there are certain statical relations between the moments, shears, and loads in a slab, as there are in a beam. These may be stated in the form of equations. The relations between moment and deformations are expressed in much the same manner as for a beam. By substituting the equations relating the bending and twisting moments to the deflections into the equations of statics, one derives the fundamental equation,[1,2] first obtained by Lagrange, relating the deflection to the load on the slab. The problem of flexure of a slab is solved by the ordinary theory when the solution of Lagrange's equation is found, subject to the proper conditions at the supports or boundaries.

For the analysis to be strictly applicable, the stresses at an edge or boundary of the slab must be distributed over the depth in the same manner as for an interior section. But this is seldom actually the case. At a fixed edge, the manner of clamping the edge introduces some disturbances into the stress situation near the edge. At a simply supported boundary, the bending moment can be made to be zero, but in general the twisting moments will not be zero. It is possible to consider the twisting moment couples replaced by statically equivalent couples made up of vertical shears. According to the so-called principle of Saint-Venant, this replacement leads to disturbances only in the vicinity of the edge, but does not affect the stresses in the interior regions of the slab. A similar consideration applies in the case of an unsupported boundary.

A corresponding replacement of one set of forces by another statically equivalent set is required in handling a reaction distributed along the under surface of the slab, or a concentrated load on top of the slab, since the theory assumes the shears to be distributed over the face of every section. For these conditions, and for other similar cases, the stresses in the region of the concentrated load, the reaction, or the edge, must be investigated by other means than the ordinary theory.

Static Controls. In many cases we can compute total moment or total shear on a section of the slab by statics. For example, in a square slab uniformly loaded, not fixed or continuous at the edges, the average moment per unit width across the diagonals is $^1/_{24}$ the total load on the slab. This is true regardless of whether the slab is supported by rigid or by flexible beams, or whether the corners are held down or are free to lift up. Such a relationship may be called a "static control" on the moments.

For a number of other cases we can derive similar static controls. For example, in a rectangular panel of a simply supported slab, the total moment in the slab and the supporting beams on any section parallel to one pair of supports is equal to the static moment of the loads. We do not know the way in which the total moment is distributed between the slab and the beams nor the manner in which the moment in the slab is distributed across the slab, but we do know the total.

Other useful relations are derivable from the well-known condition that in any span of a continuous beam the moment diagram consists of the moment diagram for the loading in the span considered as simply supported, superposed on the straight-line moment diagram connecting the end moments in the span. Instead of a span of a continuous beam we can substitute a row of adjacent panels of slabs and their supporting beams, cut by sections clear through a building. With a modification for the size of the column capital, the concept leads to the important formula for flat slabs derived by John R. Nichols.[3]

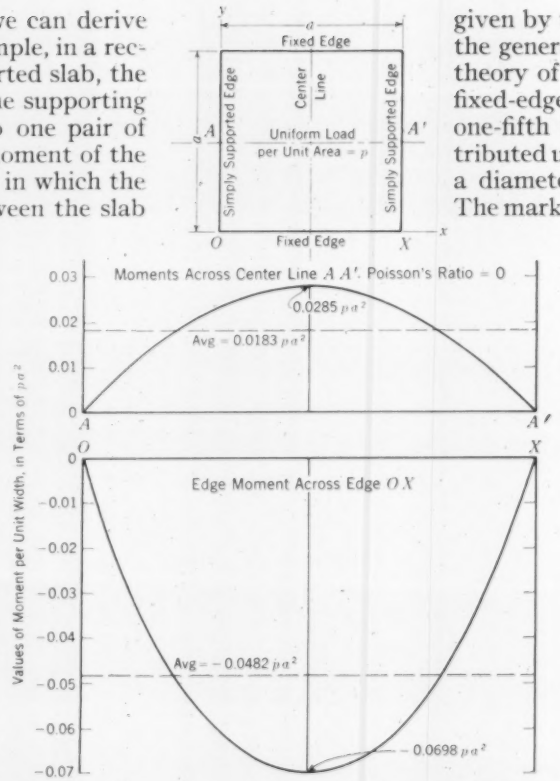

Fixed Edge
Simply Supported Edge
Center Line
Simply Supported Edge
Uniform Load per Unit Area = p
Fixed Edge
Moments Across Center Line A A'. Poisson's Ratio = 0
0.0285 pa²
Avg = 0.0183 pa²
Edge Moment Across Edge O X
Avg = − 0.0482 pa²
− 0.0698 pa²
Values of Moment per Unit Width, in Terms of pa²

FIG. 1. MOMENTS IN A SQUARE SLAB WITH TWO OPPOSITE EDGES FIXED, SUBJECTED TO UNIFORM LOAD

Such measures of the moment in a slab are extremely useful in view of the fact that they are independent of the properties of the material or the exact details of the supporting conditions.

Typical Distributions of Moments in Slabs. Methods using the ordinary theory of flexure in calculations are given by Jensen[4,5] and Newmark[6] among others. As an example of the type of results given by analysis, consider the square panel shown in Fig. 1. The positive moment of the center line of the panel and the moments at the fixed edge, when two opposite edges are fixed and the other two simply supported, are shown. The reduction in positive moment, from that in a simply supported square slab, due to fixing of the two edges is very small, about 23%, whereas the negative moments are about 90% greater than the positive moments at the center of the panel for a simply supported panel.

The maximum values of the positive and negative moments are respectively 55 and 45% greater than the average values. There may be a more marked nonuniformity in distribution of moments in a slab subjected to concentrated loading than in a slab subjected to uniform loading. This suggests that there is opportunity for considerable reduction in intensity of maximum moment in a reinforced concrete slab when the material yields with increased load.

If the slab in Fig. 1 is continuous in one direction only, with a large number of panels of the same size, and every alternate span is loaded, the moments will be the average of the moments for the slab fixed at two edges and those for the same slab simply supported on all edges. This gives an idea of the small theoretical reduction in the positive moment due to continuity with adjacent spans.

When the load is relatively highly concentrated, the stresses in the vicinity of the load are not accurately given by the ordinary theory of flexure. The stress distribution on a line through the center of the load, as given by the more accurate theory, based on the general three-dimensional relations of the theory of elasticity, is shown in Fig. 2 for a fixed-edge circular slab with a depth equal to one-fifth the diameter and with a load distributed uniformly over a circular area having a diameter one-half the depth of the slab.[7] The marked non-linear character of the stress distribution is worthy of attention.

Westergaard has suggested an approximate method by which the more accurate theory of flexure may be used conveniently. He assumes that the actual distribution of load is replaced by some fictitious distribution which gives the correct tensile stress at the bottom of the slab immediately beneath the load when the ordinary theory of flexure is used with the fictitious loading. He has given formulas[2] by which one may arrive at the equivalent area of distribution of load. The moment which is computed from the fictitious distribution of loading is, however, not the true moment but a fictitious moment. Consequently it may be inaccurate to compute stress in the steel for a cracked concrete section from this fictitious moment.

Shearing Stresses in Slabs. For uniform loads on simply supported rectangular panels the maximum reaction per unit of width at the supports, and consequently the maximum shear near the support, is practically equal to the intensity of loading times half the short span. The maximum shear does not differ greatly when the panel is fixed at the edge or continuous with other panels. However, the reaction is not distributed uniformly around the edge and may distribute itself more equally before failure. Since a rectangular slab is generally very shallow compared with a concrete beam having the same span, the shearing stresses in a slab are generally not critical. There is considerable evidence that a rectangular slab of ordinary proportions that is adequately designed for flexure will be adequate in shearing resistance.

In the neighborhood of a concentrated load, the total shear on any section around the load is easily computed by statics, and unless the load is near a support, the shearing stresses are practically uniformly distributed around the section. There is experimental evidence to show that for a concentrated load the maximum shear for a load near the support is not so important as for a load removed from the support. It requires a somewhat greater force to cause failure near a support than in the central part of a slab.

It is rather impracticable to reinforce a slab for shearing stresses, or rather diagonal tensile stresses, due to a moving concentrated load, since the problem becomes one of providing shear reinforcement everywhere in the slab. For heavy fixed concentrated loads, if the shearing stresses are significant, it is usually simple enough to provide adequate reinforcement.

Validity of the Assumptions in the Analysis. Ultimately the only test of the validity of the assumptions made in the analysis is agreement of the results obtained by analysis with those actually observed. In making com-

parisons of analytical and experimental results, the properties of the materials enter into the picture. We can measure strains but not stresses. Although we can determine steel stresses fairly well from measured strains, the calculation of the steel stresses from theoretical values of moment depends on the assumptions we may make for the action of a cracked concrete section in flexure.

It seems necessary to point out that a comparison of computed and measured deflections of a slab, as a means of verifying the accuracy of the theory, is almost worthless.

The departures of the properties of reinforced concrete slabs from those assumed in setting up the analysis are in general of such a nature as to permit the theory to be on the safe side. There is only one serious discrepancy and that is involved in the assumption of homogeneity of the material. If, for example, a square slab reinforced by bars parallel to the sides cracks severely it may have a reduced torsional resistance, and a consequent increase in stress over the stress computed by the theory. However, experiments do not show such a reduced strength of slabs nor indicate such diminished torsional resistance.

Reserve Strength of a Reinforced Concrete Slab. We may expect theoretical studies to indicate greater stresses in a reinforced concrete slab than the stresses actually existing at relatively high loads. The explanation lies in the yielding of the material, which permits a redistribution of the stresses in a more nearly uniform pattern. Westergaard[8] discusses in some detail the phenomena of redistribution of stress and cites evidence for using in design smaller moments than are indicated by the theory of elasticity.

Consider the slab shown in Fig. 1. Before failure of the structure can take place, the slab and its supporting beams possibly can act so as to apportion the total moment between them in the most effective manner. Failure on any section will not take place in general until nearly all the steel crossing the section reaches the yield point. When the most highly stressed bars start to yield they cease to take additional stress while continuing to deform. Adjacent bars take over the burden and transfer the moment laterally. Of course there is a limit to the transfer of moment along the section from point to point, but we can obtain some measure of the limit from experiments.

In a manner similar to the lateral transfer of moment there can be transfer of moment from section to section. If the negative steel at the fixed ends becomes overstressed, the moment is transferred toward the center section until that section too reaches the yield point. If too little negative moment is provided for at the supports, the ultimate strength of the structure may be kept unaltered by furnishing increased reinforcement for positive moment in the interior of the span.

When the deflections of a slab without lateral restraint at the edge become nearly equal to the depth or greater than the depth, the direct stresses in the slab become important in contributing to the carrying capacity of the structure. A slab with large deflections acts in some respects as an inverted dome. The bending stresses at the center are decreased but direct tensions are added at the center. Compressive stresses are developed near the supports to balance the central tensions. The net tensile stress at the bottom of a homogeneous slab is not reduced materially from the value computed on the basis of flexural action alone until the deflection becomes greater than the depth of the slab.[9] When the edges of the slab are restrained against lateral movement, high tensile stresses can be developed with even small deflections, and a considerably larger reduction in stress at the center of the panel can be effected. The reduction in net tensile stress may begin to be important at deflections perhaps equal to half the depth of the slab.

RESULTS OF EXPERIMENTS

Stages in the Behavior of Reinforced Concrete Slabs. It appears from the experimental evidence that we can distinguish three stages in the behavior of a medium-thick

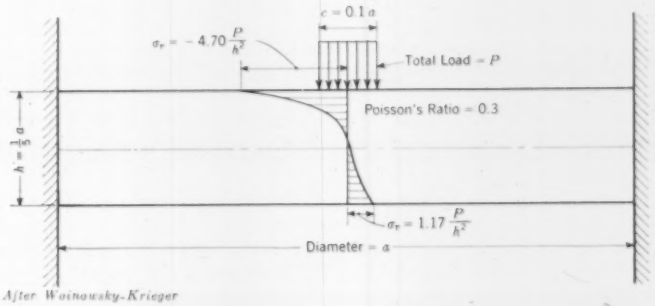


FIG. 2. DISTRIBUTION OF STRESSES IN RADIAL DIRECTION ON VERTICAL PLANE THROUGH CENTER OF FIXED-EDGE CIRCULAR SLAB SUBJECTED TO CONCENTRATED LOAD

slab of reinforced concrete with reference to magnitude of the load applied.

For low loads, before cracking of the concrete takes place, the material behaves very nearly as an elastic, isotropic, homogeneous material, and the stresses agree reasonably well with those computed on the basis of such assumptions.

The next stage in the behavior of the structure is that in which the concrete is cracked either because of the stresses arising from the loads or because of shrinkage of the concrete. However, up to the point at which the steel begins to yield, the stresses away from the regions that have been cracked do not differ greatly from those predicted by the theory. In the region of high stresses where the concrete is cracked, there is some tendency for the slab to permit a redistribution of moments, but there is no marked redistribution until the steel begins to yield. Especially at working loads the theory leads to fairly accurate results unless the reinforcement is placed in such a way that the steel at particular sections is considerably overstressed at these loads.

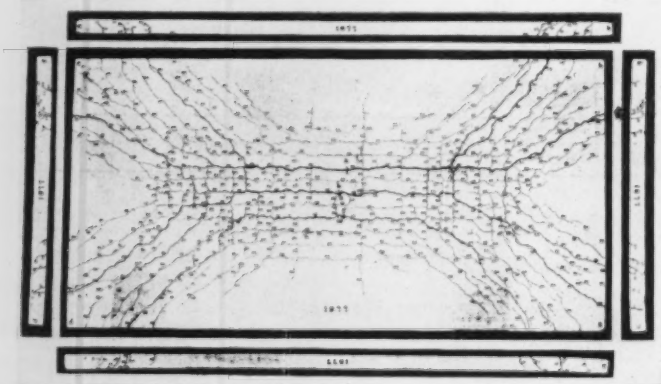
The third stage arises when yielding of the steel takes place. Here the tendency for redistribution of stresses is greater, and in general more and more of the slab participates in "carrying the load" as the load increases to its ultimate value, or until failure occurs. The relative loads at which the transition from one stage to the next occurs are dependent on the amount of reinforcement and its arrangement.

Summary of Results of Experiments. Examination of experimental data seems to indicate that the concrete in a slab cracks at about the computed moment required to produce the ultimate tensile strength in the concrete at the top or bottom of the slab. Furthermore, cracking in a slab takes place at the same moment per unit of width as in a beam of proportions and reinforcement corresponding to a unit width of the slab. That is, the actual factor of safety against cracking of a reinforced concrete slab is exactly the same as in a corresponding beam of the same depth and reinforcement.

In tests reported by Richart and Kluge,[10] of concrete slabs subjected to concentrated loads, observed compressive strains in the concrete show a fairly good agreement

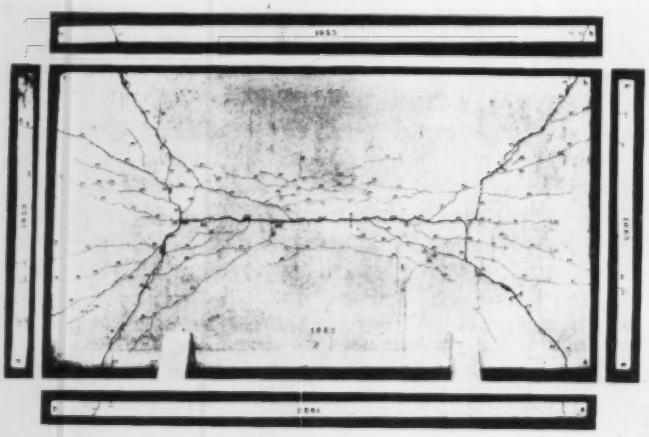
with theory in view of the uncertainties involved in making the comparison. The measured steel strains are almost without exception less than the theoretical steel strains computed on the basis of no tension in the concrete, but are greater than for full tension in the concrete except for points near the supports. The steel strains near the load become more nearly equal to the theoretical values for no tension in the concrete as the load becomes large.

The values of the loads producing first yielding of the steel in the large slabs tested by Richart and Kluge[10] ners and those with all their reinforcement at the bottom of the slab. Both types of slabs were tested with corners held down and the latter also with corners free to lift up. Calculations of steel stress at the center of the slabs by means of the ordinary theory of flexure, for a value of Poisson's ratio of zero, from the maximum loads reported by Gehler, indicate stresses at failure of 1.05 to 1.44 times the yield point of the reinforcing steel, with an average of 1.26 times the yield point. Calculations based on the average moment across the diagonal, taking into account the actual amount of steel in the slab, indicate stresses at failure of 1.33 to 1.79 times the yield point of the reinforcement, with an average of 1.52 times the yield point. From the tests reported by Gehler of beam strips representing a narrow strip along the center line of the various slabs, calculations indicate steel stresses at failure of 1.32 to 1.50 times the yield point of the reinforcement, with an average of 1.40 times the yield point. It should be noted that the amount of reinforcement at the center of the slabs, in accordance with the usual notation, varied from 0.30 to 0.48%.



From Tests by O. Graf

(*a*) Transverse Reinforcement Equal to Main Reinforcement, per Unit Width



From Tests by O. Graf

(*b*) Transverse Reinforcement Approximately One-Tenth Main Reinforcement

FIG. 3. CRACKS IN RECTANGULAR SLAB SUPPORTED ON FOUR SIDES AND SUBJECTED TO APPROXIMATELY UNIFORM LOADS

averaged about 1.27 times the theoretical value of the load required to produce yielding of the reinforcement. Failure occurred at very nearly twice the theoretical load required to produce yielding of the reinforcement. The slabs failed by punching out of a cone of concrete under the load.

Calculations reported by Westergaard[1] for tests by Bach and Graf[11] on slabs subjected to uniform loads, indicate computed stresses in the reinforcement at failure from 1.05 to 1.57 of the yield point of the reinforcing steel, but only from 0.90 to 1.29 times the stress producing yielding of concrete control beams.

A very complete series of tests of slabs subjected to uniform loads was reported by Gehler and Amos[12] in 1932. Slabs were designed by various procedures and tested to failure. Some of the tests were intended to bring out differences in strength of simply supported square slabs reinforced for torsional moments at the cor-

From these tests it appears that there was relatively little more reserve strength in the slabs than in beams having the same depth and reinforcement. On the other hand, a slab subjected to concentrated load, or a slab that is fixed or continuous at the edges, appears to have more reserve strength, but just how much has not yet been accurately determined by experiment.

The influence on manner of failure and on ultimate strength of different arrangements of reinforcement has been studied experimentally only to a limited extent. Tests reported by Graf[13] on simply supported rectangular slabs subjected to uniform loads indicate the general nature of the effect of difference in amount of transverse and main reinforcement. Figs. 3(*a*) and 3(*b*) show views after failure of slabs tested by Graf in which the main reinforcement was the same, but the area of transverse reinforcement per unit width was equal to the area of main reinforcement per unit width in Fig. 3(*a*) and one-tenth as much in Fig. 3(*b*). The former slab carried 25% more load than the latter.

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The Horse-and-Buggy Days of Bridge Building

By H. S. Tullock

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From the close of the Civil War to the turn of the century is roughly the period catalogued by Mr. Tullock as the "horse-and-buggy days of bridge building." Confining himself in the main to the Mid-West, he gives interesting descriptions of the operations on a number of large bridges—including the Hannibal Bridge—and recounts some anecdotes about the "mail-order" spans for the county wagon roads as well. His paper was on the Construction Division program at the Society's 1940 Spring Meeting.

CONSIDER for a moment the design and construction methods for a modern bridge across one of the larger rivers. Eliminate, one by one, the following: alloy steel, reinforced concrete, acetylene and electro welding, wide-flange and special steel sections, steel sheet piles, gasoline and diesel powered portable equipment, hand air tools, steam pile hammers, and to a degree even concrete mixers. To the credit side add cheap living with its resulting low wages, a recognition of the value of the work performed rather than of the time consumed in doing it, plentiful and comparatively cheap lumber and timbers, and—a boon that was appreciated only as the accepted right of every American—the right to control and operate without outside interference. There then remain the materials, tools, available methods, and conditions under which bridge construction was carried on at the end of the last century.

The general foundation methods of that period, the crib or cofferdam system, the pneumatic process, and the open dredging process, were little different from those in use today. With the development of the steel sheet pile, reinforced concrete, and dredging equipment, the limitations as to depth of sinking have been greatly broadened in both open sinking methods.

The cofferdam system, in which an open timber crib was constructed, loaded, and sunk by dredging, was recommended only for depths of 15 or 20 ft. On account of the inflexibility of the crib, and the danger of racking, with resultant leaks, it was not adaptable to many situations.

Wakefield pile cofferdams were also used, the piles constructed by the bolting together of three 3 by 10 or 3 by 12-in. planks, making a 9-in. section, the center plank being allowed to protrude to form a tongue and groove. Since this was the only device for interlocking, considerable difficulty was often encountered in obtaining a tight cofferdam, and the depth to which this device could be satisfactorily used was limited.

The iron or steel cylinder in pairs was the most common form of pier in use in this period. The cylinders were sunk by open dredging or at greater depths by the pneumatic process. In the open dredged cylinders, piles could be driven where necessary. The cylinders were strutted and braced together, filled with concrete, and in some instances capped with a plate. Where properly designed they gave good service. Unfortunately they were often used in light highway structures where little attention was given to the needs of stability or to bank pressures.

For greater depths, the pneumatic process was generally favored. It was first used in this country in 1855 in the construction of the piers of the Wilmington, Columbia and Augusta Railroad over the Grand Pedee River in North Carolina. These piers were of the twin-cylinder type and the method was known as the pneumatic pile system. The cylinders and lock were of cast iron.

In 1869 Gen. William S. Smith, M. Am. Soc. C.E., used this method in sinking the steel cylinders under the Union Pacific bridge at Omaha to a depth of 82 ft—the record of the day—and before the completion of this bridge, in 1871, he started the construction by the same method of the piers under the combination highway and railroad bridge for the Rock Island Railroad at Fort Leavenworth. To General Smith, incidentally, goes the credit for an important development in the pneumatic process, developed in the course of an earlier job (1859) on the Savannah River. Up to that time, excavated materials had been "bucketed out" through the air lock. Then, one day, he noticed a "puff of sand" in the water from a drain pipe leading into the caisson. Upon investigating, he discovered that this pipe had, in sinking, reached the level of the sand bed inside the caisson. From this chance occurrence developed the "blow pipe" method of sand excavation. (See his paper on "Pneumatic Foundations," Transactions, Vol. 2, 1874, page 411.)

The Eads Bridge in St. Louis was the first in this country to be founded on large pneumatic foundations, these foundations having a maximum immersion of 109 ft 8½ in. This bridge was built in 1870. In 1911 one

The Hannibal (Kansas City) Bridge, Just After Its Opening in 1869
All Pictures in This Article Are from Lithographs in Chanute and Morison's Book, *The Kansas City Bridge*

of the piers of the Municipal Bridge at St. Louis was worked at a maximum immersion of 113 ft, which is probably the record for pneumatic sinking with the possible exception of a caisson in Denmark which was

LOWERING CAISSON NO. 1, KANSAS CITY BRIDGE
(SEPTEMBER 6, 1867)

Each of the eight timber posts was 60 ft long, and had a central hole through which a 2-in. steel drill might be worked. After the caisson had been floated into place, the posts were sunk through the sand by their own weight and were made fast by working the drills 2 ft into the rock. They were then braced together and secured to the caisson by rollers and shoes, and the weight of the caisson was transferred to them through suspension screws, 20 ft long, hung from cross-timbers. The caisson was then lowered to a sand bearing by turning the screws.

reported to have reached a working depth of 115 ft. It is interesting to note that in its infancy, the pneumatic process developed almost its maximum depths.

In the nineties, this process was being used extensively for deep foundations and was particularly favored because it was relatively easy to control and because it permitted the removing of chance obstructions and the complete investigation of foundation materials in place.

GENERAL FORM OF THE CAISSONS

The caissons were usually of timber construction, either of the inclined-wall or of the straight-wall type, with a steel cutting edge or shoe fitted to the beveled section of the bottom timber.

In the inclined or V-wall type, the walls of the working chamber were built on a 45° angle and of 17 by 17-in. timbers fastened by long bolts to the outer vertical wall timbers of the caisson. The roof of the working chamber was of three courses of 12-in. timbers. Concrete was placed in the wedge-shaped space between the inner and outer walls and above the roof.

In the straight-wall type the walls and roof were built of 12 by 12-in. timbers in three courses, the inner and outer being horizontal and the middle course vertical. On the inside of the working chamber and on the outside of the caisson was placed 3-in. friction planking, the latter being calked, making the walls and roof $3^1/_2$ ft thick, of solid timbers. One of the authorities of the day stated in his handbook that the roof of the caisson "should never be less than 4 ft or more than 8 ft thick."

The timbers of caisson, crib, and cofferdam were fastened together at proper intervals with $^7/_8$-in. drift bolts. The holes for these bolts were bored to a $^3/_4$-in. diameter by hand with ship augers and the drifts driven by two men swinging 8-lb mauls. The job of balancing on timber 10 or 12 in. wide for a 10-hour stretch while laboriously twisting the offset handle of the auger was not one that would be attractive to many workers of the present.

Lighting inside the caisson was accomplished by candles and in some instances by miner's lamps worn by the workmen. The hazard of fire from these open flames was considerable and numerous accidents are on record from this cause. Needless to say, there was no telephone communication between the inside of the caisson and the outside. Necessary messages of standard type were transmitted by giving a certain number of raps according to a prearranged code.

General Smith, in the aforementioned paper, tells of an attempt to light the lock and shaft by setting glass bull's-eyes 1 in. thick and 6 in. in diameter in the doors of the lock. The results were unsatisfactory, however, as mud from the men's boots quickly caked the glass, cutting off all light.

The first bridge to be constructed across the Missouri River was at Kansas City and was known as the Hannibal Bridge, taking its name from that of the railroad—the Kansas City, St. Joe and Hannibal—in whose interest it was built. Its completion in 1869 marked the turning point in the prosperity of Kansas City and the end of a ten-year strife for railroad supremacy between Kansas City and Leavenworth. Octave Chanute and George S. Morison, both of whom later became presidents of the Society, were, respectively, chief engineer and assistant engineer on this project, and in their book, *The Kansas City Bridge*, they give a complete account of its construction.

The main piers were built by the open dredging method. A cofferdam was constructed and excavation accomplished by means of a dredge consisting of buckets on an endless chain. In the shallower piers the dredge was operated by four men and had a capacity of about 50 cu yd a day. On Pier 4, which was sunk to a depth of 56 ft, a caisson was constructed and four dredging wells provided, each with a similar dredge with telescopic frames allowing a range of length from 51 to 81 ft. The dredges were raised or lowered by chains controlled by crabs. A single overhead line-shaft, powered by engine and with individual control for each dredge, was operated. Considerable difficulty was encountered in building and sinking the caisson for this pier owing to shifting channel and scour. One caisson was lost and the location of the pier moved 50 ft south to avoid encountering its wreckage. This change in location necessitated the transposition of two spans.

All piers were of masonry. A special box for handling the concrete, or "beton" as it was then called, was devised for under-water work, and was evidently the forerunner of the present-day bottom-dump bucket.

CONSTRUCTION EQUIPMENT FOR KANSAS CITY BRIDGE

The entire list of equipment used on this work, exclusive of small tools, is as follows:

- Machine shop, consisting of a Daniels planing-machine, circular saw, lathe, screw cutter, drill, and blacksmith tools
- 1 steamboat 135 ft long
- 4 barges 53 by 18 by 3 ft
- 3 small barges
- 1 large yawl and skiffs
- 4 portable steam engines of 8, 12, 15, and 25 hp
- 1 9-in. Alden centrifugal pump
- 1 4-in. Andrews centrifugal force pump
- 1 6-in. siphon pump
- 1 donkey pump for jetting
- 1 diving outfit
- 4 large dredges with attachments
- 1 small dredge
- 3 pile drivers with 2,200-lb hammers
- 8 land derricks—horse powered
- 1 sawing machine (for cutting off piles under water, operated by six men)
- 5 beton boxes
- 2 steam crabs
- 6 hand crabs

In connection with this equipment list Chanute and Morrison remark that "the isolated position of Kansas City, its distance from manufacturing and commercial centers, and the unsettled character of the neighboring country, were most felt at the beginning of the work in the collection of a suitable outfit." Even as much as thirty years later, it was fortunate that by far the greater part of the large bridges were built on the railroads or in cities having rail facilities, as the problem of transporting heavy steam equipment over poor roads was a serious one. At best, the handling of this equipment from a railroad spur to its plant location called for much cribbing and bending of backs, for it was largely a strong-arm job.

On the larger rivers floating equipment was sometimes used, but more often a "tram" was constructed over which all materials were transported. The concrete plant was ordinarily near the railroad spur, where materials could be unloaded and stock-piled by a stiff-leg derrick of timber construction. Bins and measuring hoppers were little used, the aggregate and cement being transported in wheelbarrows to the charging hopper, the required mix determining the number of wheelbarrows of sand and of rock and the number of sacks of cement used per batch. Water was introduced not by measure but largely by the judgment of the operator—a far cry from the elaborate weighing or measuring devices that are now in use. Yet good concrete was obtained. The concrete when mixed was placed in buckets, loaded on small flat cars, and pushed out to the required location by a steam dinky engine on a 3-ft-gage tram track. A stiff-leg derrick at each pier location handled the concrete to the pier. It was usually demonstrated that, while on the near pier some delay often occurred, by the time the most remote pier was concreted the dinky and loaded flats would be pushing the concrete gang, for the engine operator by that time disdained to operate except with wide-open throttle.

An impressive piece of equipment where long piles were to be driven was the skid driver—sometimes with leads 90 ft high. It required a skilled operator to "pick" the drop-hammer on its rebound, but it was done in a way that created a clock-like rhythm.

In the power house were the steam-driven compressors. These were of the opposed type and there were at least two of them, with a battery of three or more horizontal boilers. Adjoining the boilers were bins for the storage of coal, a large quantity of which was required. An office, blacksmith shop, tool house, and "hog" house completed the set-up.

In the sandhog house were wooden bathtubs, and hot coffee was given to each outcoming shift. Hospital locks were considered a "frill" and supplied only on work requiring very deep sinking. Nearly every job had its camp and commissary. While the allowed cubic footage per man in the bunk houses would probably have fallen short of the requirements of present state health departments, the food supplied was as a rule both plentiful and good. Since board and bed were charged for at the rate of only $3 or $4 a week, these camps, except on long jobs, seldom "broke even."

In the erection of the steel superstructure, travelers were ordinarily employed and for the most part were of the "outside" type. Inside travelers were used on smaller structures because of the saving in materials and falsework. These travelers were built of timber and rested on wheels, for which a special track of rails was provided. The track of the outside traveler was laid along the falsework since the traveler encircled the entire span. On this account it was often a hundred feet high. The frames of the traveler were assembled and built usually on the falsework and raised into position; this was perhaps the most hazardous operation in the entire erection process.

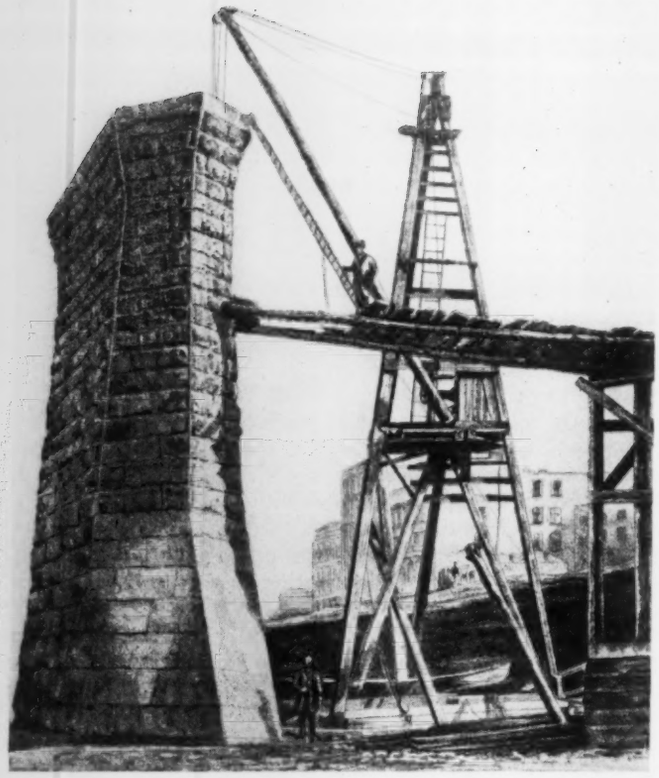
On cantilever spans, an overhead traveler was often constructed and moved out on the top chords. Manila rope was used in rigging and handling the steel.

A PONTOON BRIDGE OF THE 1880's

Before leaving the "big" rivers, mention should be made of an early pontoon crossing of the Missouri. Prior to 1888 a number of such bridges had been built on the upper river, and in that year Vinton Stillings obtained a permit from the War Department for the construction of one at Leavenworth. The pontoons were constructed on the river bank of the military reservation a mile above the city and when completed were floated into place. The bridge, 1,400 ft long with an 18-ft roadway, consisted of seven sections, each 200 ft long and each supported on 14 pontoons 12 ft wide and 24 ft long. The pontoons were anchored by cables to large limestone boulders which had been lowered to the river bed. Aprons that could be raised or lowered were constructed at each end to allow for the rise and fall of the river. The center sections were hinged at each end to allow the free ends, when released, to float downstream, permitting the passage of boats. A capstan boat was stationed above, for use in drawing the sections back into place. The bridge was built in less than a year at a cost of $36,000. Its opening was in August 1889, and

OTHER VIEWS OF CAISSON WORK ON THE KANSAS CITY BRIDGE

At Left: Towing a Caisson Into Position. At Right: Falsework on Pier 4, Which Provided Complete Housing for the Four "Endless-Chain" Dredges Used in Excavating the Caisson



FLOATING DERRICK AND SCAFFOLDING USED IN LAYING PIER MASONRY FOR THE KANSAS CITY BRIDGE

was celebrated by the driving of the local fire engine, with black smoke pouring from its stack, across and back at a gallup.

Considerable difficulty was experienced in holding the pontoons during high water and it was several times necessary to send a steamboat after truant sections that had broken loose and were being carried southward by the current. During the winter season the pontoon sections were removed and anchored to the bank. The bridge continued in operation until 1893, when a combination railroad and highway bridge was built to replace it, at the city. In the meanwhile a similar pontoon bridge had been promoted at Lexington, Mo.

But to return to more conventional structures. Smaller bridges, away from the railroads, presented a different problem from those on the big rivers. These bridges were financed from that portion of county taxes levied for road and bridge funds, and such levies were small. The contracts were let by the county board of commissioners, aided by the county surveyor who also supplied what little inspection the construction received.

MAIL-ORDER BRIDGES FOR COUNTY ROADS

Plans were usually supplied by the bridge companies, represented by bridge salesmen, each armed with a book of "standards." These "standards" consisted of plans for trusses of from 30 to 90 ft, each designed for roadways of 12, 14, and 16 ft. Woe to the young engineer fresh from college, who, on the dresser top in an unscreened hotel room, under the light of a kerosene lamp, designed his own bridge and submitted it with his proposal! With much shaking of heads and comparison of standards, the verdict was usually handed down that it just "wouldn't carry." The story is told of a certain bridge salesman and a county surveyor, both seated on a log at the site of a proposed bridge, and both whittling. "Mort," asked the surveyor, "what is the component of security of your bridge?" Mort, to whom the term "factor of safety" would have been equally baffling, but playing safe, replied, "Oh, about fifty or so." To this the surveyor, after more whittling and consideration, responded, "Little enough, little enough."

Even for the larger highway bridges, little equipment could be transported over the roads both because of their condition and because little hauling equipment was available, aside from ordinary farm wagons. The foundations were usually of steel cylinders or masonry. The equipment consisted largely of hand tools with crab, drop-hammer, small orange-peel dredge, riveting forge, and blocks and line.

A request for additional equipment on the part of a field foreman once brought about the protest "Pete, what's happening to you? You used to carry your tools out in a grip sack—now you want a car load." The rejoinder was "Yes, Boss, but you used to send the bridges out by mail."

Rivets were hand driven; piles were driven with a "Joe Heaver" driver, powered by a horse that after each blow plodded methodically back to allow the nippers to be engaged again in the hammer. Concrete was mixed by hand on a mixing platform—the rock wet down and spread with the sand, the cement distributed, and the whole "turned" by a crew of shovelers. One old-time contractor often stated that when he had to mix concrete with anything but negroes he'd quit. The crews were recruited largely from farm boys who six days of the week worked their ten hours a day and then went home to do their chores. Nevertheless, these bridges served their purpose.

All this was changed with the coming of the automobile, hard roads, the Bureau of Public Roads, and the resulting creation of state highway departments, until today these well-organized departments are utilizing the best of consulting resources and are providing the bridge construction industry with by far the greater bulk of its work.

Today the timber caisson has been replaced with that of steel or reinforced concrete, and heavy equipment can be transported by specially built trailer trucks capable of carrying 50-ton loads on multiple rubber-tired wheels over concrete pavements. Crawler-tread cranes transport materials and largely eliminate the use of derricks. The skid driver has given way to the steam-hammer operated on swinging leads. Diesel-driven air compressors have eliminated the battery of boilers with their coal storage bins; portable air compressors supply power to many tools previously operated by hand; speedy whirlies drop their massive 2-yd clamshell dredges to under-water depths of 200 ft and more; and locomotive cranes have made travelers unnecessary. Gone is the camp and in its place are individually owned house trailers and lines of workmen's cars waiting to transport their owners to homes twenty miles away when their 6- or 8-hour shifts are finished.

The horse and buggy has passed down the dusty road and over the horizon, and in its stead myriads of rubber-tired vehicles glide over endless ribbons of concrete. The little eight-wheeled "iron horse" with its funnel-shaped stack has given way to the compound Mallet and the diesel-powered streamliners, and its progeny have, like Pegasus, developed wings. Many of the old structures still stand and many have been replaced. But old and new alike, they are founded upon the courage, the foresight, and the experience of those men whose will surmounted the obstacles that are a part of all pioneering, and to whom the slogan, "It can be done," was law. Time marches on!

Highway Design Trends in the Western States

With Special Reference to Colorado Practice and Progress

By C. D. VAIL

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VEHICLE speeds and safety requirements are so interwoven that it is difficult to consider one without the other, says Mr. Vail in introducing this review of highway design practices. The first part of the article treats particularly such matters as curve radius and passing and non-passing sight distances, while the latter contains an interesting assemblage of traffic accident data from the Colorado State-Wide Highway Planning Survey, illustrating graphically the relative importance of various accident factors in urban, semi-urban, and rural areas. This paper was originally scheduled for presentation on the Highway Division program at the Society's 1940 Spring Meeting in Kansas City.

PERHAPS the first wheeled vehicles to traverse our western prairies and mountains passed over the Santa Fe Trail, the California Trail, the Overland Trail, the Smoky Hill route, and the Oregon Trail. These primitive routes furnished very little in the way of a roadbed, and the caravans of wagon trains, each doing its own road work—just enough to get through—resulted in very little improvement of value to those who followed. In this period, from 1822 to 1875, directness between termini was sought, but design for speed was unnecessary, and the principal requirement appeared to be safety against marauding Indians and land pirates.

In 1849, Overland stages were placed in service. These vehicles were elegantly built and gorgeously painted; they were designed to carry eight passengers with a fully armed guard of eight men on the outside. The stage bodies were of watertight construction so that they could be used as ferries where streams were too deep for fording.

The pioneers of this period were busily experimenting to improve transportation facilities through the western areas. Better stages, the pony express, and sail wagons were tried. A Mr. Fortune, an experimenter in Kansas, built a steam wagon intended to run between Atchison, Kans., and Denver, Colo. The machine, 20 ft long, and equipped with wide-tired wheels 8 ft high, performed successfully at 8 miles an hour on several trial trips around Atchison. The maiden trip to Denver was scheduled to start July 4, 1860. But the hand of destiny was against Mr. Fortune. As his machine began the journey, something went wrong with the steering gear and the excited driver was unable to stop, with the result that the steam wagon crashed into a building, wrecking both the building and the vehicle. Thus Mr. Fortune's misfortune put an end to his plans, and what might have been the advent of the automobile was delayed for forty years.

For about thirty years following the Civil War, migrations into the western territories increased, and the cities, cultivated areas, and active mining regions created strong demands for road development. Wagon trains and passenger stages stimulated road and bridge building. Private companies built toll roads, the states and counties financed the construction of numerous bridges, and intense activity to connect up the settlements and extend roads out from rail points resulted in many miles of road improvement of one sort or another.

With the appearance of the motor car the need for more extensive roads between centers of population began immediately to be felt. The natural soil road or light surfacing that carried wagon traffic quickly broke up under the pounding of the automobile. The immediate trend was to a uniform width of roadbed—drained, graded, and surfaced sufficiently to get traffic "out of the mud."

The first improvements followed very closely the narrow rights of way established in the horse-and-buggy days. Strength of road surface to meet weight demands caused great concern, and legislation was adopted to limit loads and speeds. Drainage was provided, but its correlation with soil conditions seemed haphazard.

With speed limits of 35 miles an hour, long-radius curves were not deemed absolutely necessary, and superelevation at curves was a refinement considered undesirable because slow-moving horse-drawn loads of hay might tip over. At approaches to towns, shallow "thank-you-marms" were built across the road to force the "scorchers" to slow down within the city limits. Excessive curvature at railroad crossings was advocated to force autos to reduce speed before reaching the crossing.

In 1918, Colorado adopted a 24-ft width of roadway, including shoulders, in plains areas, and a 16-ft width in mountainous stretches. Grades of not more than 6% and curves of not less than 150-ft radius were declared desirable. Since that time, the increasing numbers of motor vehicles, greater speeds, and more frequent highway accidents have developed a pressing demand for more adequate and efficient highway facilities. Out of the West have come proposals for designs based on speeds as high as 100 miles an hour. The numerous research organizations in the country have attacked the problems from many angles. The State-Wide Highway Planning Surveys were organized in practically every state to gather factual data for daily administrative use, and develop analyses and recommendations looking toward the establishment of definite, long-range highway improvement programs integrated with the economic needs of the nation. These investigations deal not only with engineering problems but also with tax structures and financial considerations.

Whereas the early road design was controlled by the requirements of getting traffic "out of the mud," the trends of the past several years have been dictated largely by vehicle speeds and safety requirements. These two factors are so intimately interwoven that it is difficult to consider one without the other.

For balanced design, every critical detail of the highway must be designed, so far as is economically possible for the assumed speed—which is the probable maximum uniform speed of the faster group of drivers. The minimum curve radius for the assumed speed is determined by the standard formula,

$$\text{Radius of Curve (in ft)} = \frac{0.067\,V^2}{S + P}$$

where V is the assumed speed in miles per hour. In Colorado, S varies from the normal cross-section crown

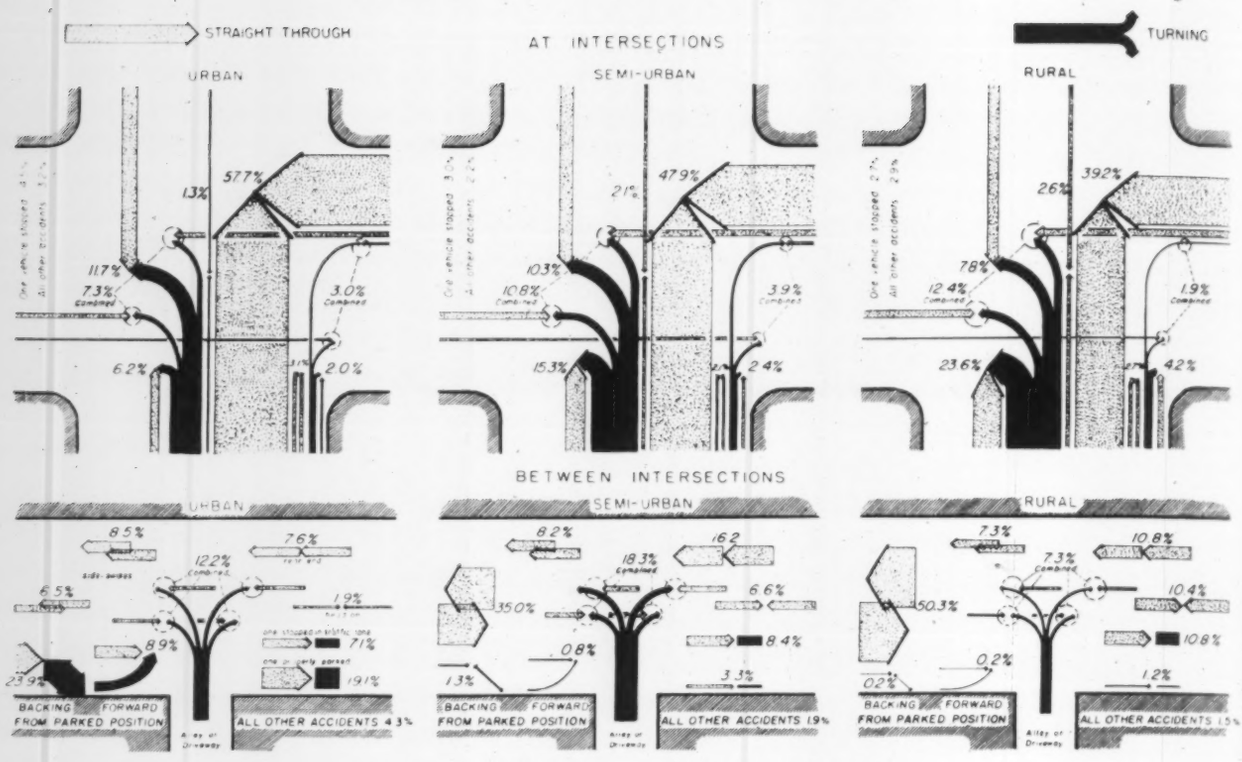


FIG. 1. WHAT HAPPENS IN TWO-VEHICLE COLLISIONS
As Revealed by the Colorado State-Wide Highway Planning Survey, Years 1936, 1937, 1938 (City of Denver Not Included)

of, say, 0.02 ft per ft of width to 0.1 ft per ft of width. In areas subject to excessive ice conditions, the tendency is to reduce the maximum superelevation to 0.075 ft per ft of width. For F, Colorado uses a value of 0.16 for speeds of 60 miles an hour or less, with a reduction of 0.005 for each increment of 5 miles an hour above 60 miles an hour.

To facilitate use of these curves at the design speeds, spiral transitions are recommended. This refinement is being used in many of the western states and is part of the required design on U.S. Forest highway projects.

NON-PASSING AND PASSING SIGHT DISTANCES

Sight distance is an essential factor in highway design. The ability to see the highway for a sufficient distance to permit the driver to control his vehicle properly in the presence of obstacles is a vital necessity.

Two types of sight distance are considered. The sight distance required to permit a vehicle traveling at the design speed to stop before reaching a stationary object in the same lane is designated as minimum non-passing sight distance. All points along the highway should have at least this sight distance. Sight distance long enough to permit safe passing of overtaken vehicles is considered as passing sight distance. Sections having passing sight distance should be provided at frequent intervals.

Minimum non-passing sight distance, in fact, is determined on the basis of the following formula for stopping distance:

$$\text{Stopping Distance (in ft)} = 4.4V + \frac{V^2}{12}$$

V being the velocity in miles per hour. The first term of this formula allows three seconds for the driver to perceive an object in the roadway and react to the point where brakes begin to decelerate the vehicle, while the second term represents the distance necessary for brakes to stop the vehicle, using a friction coefficient of 0.4. Stopping distances from various speeds, as determined by this formula, are as follows:

DESIGN SPEED	STOPPING DISTANCE
25 miles per hour	162 lin ft
40 miles per hour	309 lin ft
60 miles per hour	564 lin ft
80 miles per hour	885 lin ft
100 miles per hour	1,273 lin ft

The non-passing sight distance is measured from the eye of the driver 4.5 ft above the road surface to the top of an object 4 in. high. Using the stopping distances determined in the foregoing, the minimum lengths of vertical curves required at changes in grade over a hill crest are determined for the various algebraic differences in grade.

Minimum passing sight distances involve a wide choice of assumptions for traffic behavior. The present trend is to use the sum of three distances:

1. Distance traversed during perception time.
2. Distance traversed by passing vehicle while passing.
3. Distance traversed by an opposing vehicle during the operation of passing.

For the first item we assume that two cars are traveling in tandem at 10 miles an hour less than the design speed. The opposing traffic lane becomes clear and the driver of the rear car decides to pass. The distance (in ft) traveled during this perception time is 4.4 $(V - 10)$, where V is the design speed (in miles per hour).

For the second item, the distance traversed relative to the passed vehicle plus the distance traversed by the passed vehicle in the same period of time is $2S + 1.47\ (V - 10)\ t$, where S is the spacing between the vehicles at beginning and end of the passing maneuver, and t is the time in seconds required to traverse $2S$ relative to the slower moving vehicle. S is taken as the braking distance at design speed, and t is computed there-

from on the basis of an average relative velocity of 10 miles per hour.

For the third item it is assumed that opposing traffic is traveling at the design speed for the highway. The distance traveled by opposing traffic during the passing maneuver is 1.47 Vt.

The minimum passing sight distance then is the sum of the three items, or

$$4.4\,(V - 10) + 2S + 1.47\,(V - 10)t + 1.47\,Vt$$

The distances for the various speeds on the basis of the foregoing assumptions are:

Design Speed	Required Passing Sight Distance
30 miles per hour	643 ft
40 miles per hour	1,060 ft
50 miles per hour	1,595 ft
60 miles per hour	2,316 ft
70 miles per hour	3,236 ft

Where passing sight distance is considered, vehicles are the objects that must be seen. The height of object is assumed to be $4\frac{1}{2}$ ft, the same as for height of eye. The minimum lengths of vertical curves are developed on this basis and are tabulated for use in design.

The width of roadway cross-section required for safe operation has increased as traffic density, vehicle speeds, and truck widths have become greater. The trend generally over the entire country now is to use an 11-ft width per lane of traffic, and some authorities are advocating a 12-ft lane width where speeds are high and truck traffic is heavy. Using 12-ft lanes and 8-ft shoulders, the modern two-lane highway presents a finished width of 40 ft. This crowned width, together with 1-on-6 slopes from shoulders toward ditches, provides an improvement that should serve without congestion for mixed traffic of at least 4,000 vehicles a day.

In designing a two-lane highway, the possibility of future enlargement to three or four lanes must be considered. A plan where culverts can be extended readily or bridges widened without heavy loss of investment should be used wherever possible. Deck-type bridges are preferred in Colorado.

The use of soil studies on each project to obtain more carefully stabilized subgrades is becoming more general in the western states. More specific control of grading operations, and wetting and rolling of embankment materials are now covered in the design.

To provide a highway of pleasing appearance and to prevent erosion along and adjacent to it, a portion of the highway funds are being expended for roadside improvement projects. These improvements involve flattening slopes, constructing contour ditches, planting to provide ground cover, and constructing roadside parks where drivers can rest.

Walkways for pedestrians are now provided in urban or semi-urban areas. The trend is to construct these sidewalks along the right-of-way line instead of along the roadway shoulder.

TRAFFIC ACCIDENT DATA ILLUMINATING

The Colorado State-Wide Highway Planning Survey recently reported upon the results of a traffic accident study extending over the years 1936, 1937, and 1938. This study indicates the type of remedial measures necessary to reduce the accident frequency. Figures 1 and 2 indicate records of accidents involving two and three cars, respectively, and illustrate the percentage of accidents of various sorts in urban, semi-urban, and rural areas.

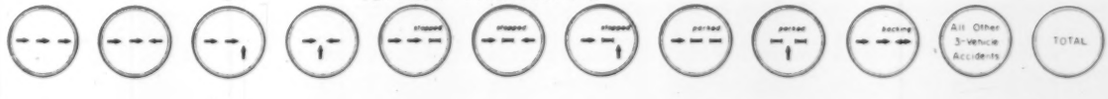
Upon inspection of the accident trends, one observation is evident: two-vehicle collisions exhibited the greatest accident frequency in all localities. In urban localities two-vehicle collisions made up 76.8% of all accidents; of these 54.8% occurred at intersections while 45.2% occurred between intersections. In semi-urban localities two-vehicle collisions were 64.2% of all accidents; of these 45.8% occurred at intersections, while 54.2% occurred between intersections. In rural localities two-vehicle collisions constituted 46.8% of all accidents; of these 18.9% occurred at intersections while 81.1% occurred between intersections.

The diagrams of two-vehicle collisions presented in Fig. 1 are designed to aid in visualizing the drivers' desires or their intended direction of travel prior to crashes. The width of the symbols is proportional to the percentage of accidents of each type, and it is of interest to note how the relative frequency of various accident types varies as conditions change from urban to semi-rural to rural. For example, in the "at intersection" diagrams, observe the accidents involving vehicles

AT INTERSECTIONS

URBAN	2.2%	None Reported		15.2%	None Reported		2.2%	2.2%	None Reported	2.2%	2.1%	73.9%	100.0%
SEMI-URBAN	5.9%	17.6%	5.9%	5.9%	None Reported		5.9%	17.6%	None Reported		5.9%	35.2%	100.0%
RURAL	12.5%	6.3%	6.2%	6.2%	6.3%	6.2%	18.8%	12.5%	6.2%	None Reported		18.8%	100.0%

BETWEEN INTERSECTIONS



URBAN	8.8%	8.8%	1.3%	1.3%	11.4%	3.8%	20.2%	30.4%	1.3%	1.3%	11.4%	100.0%
SEMI-URBAN	6.8%	52.3%	None Reported		11.4%	13.6%	None Reported	9.1%	None Reported		6.8%	100.0%
RURAL	14.6%	49.0%	None Reported		5.1%	11.6%	None Reported	12.1%	None Reported		5.1%	100.0%

FIG. 2. WHAT HAPPENS IN THREE-VEHICLE COLLISIONS

As Revealed by the Colorado State-Wide Highway Planning Survey, Years 1936, 1937, 1938 (City of Denver Not Included)

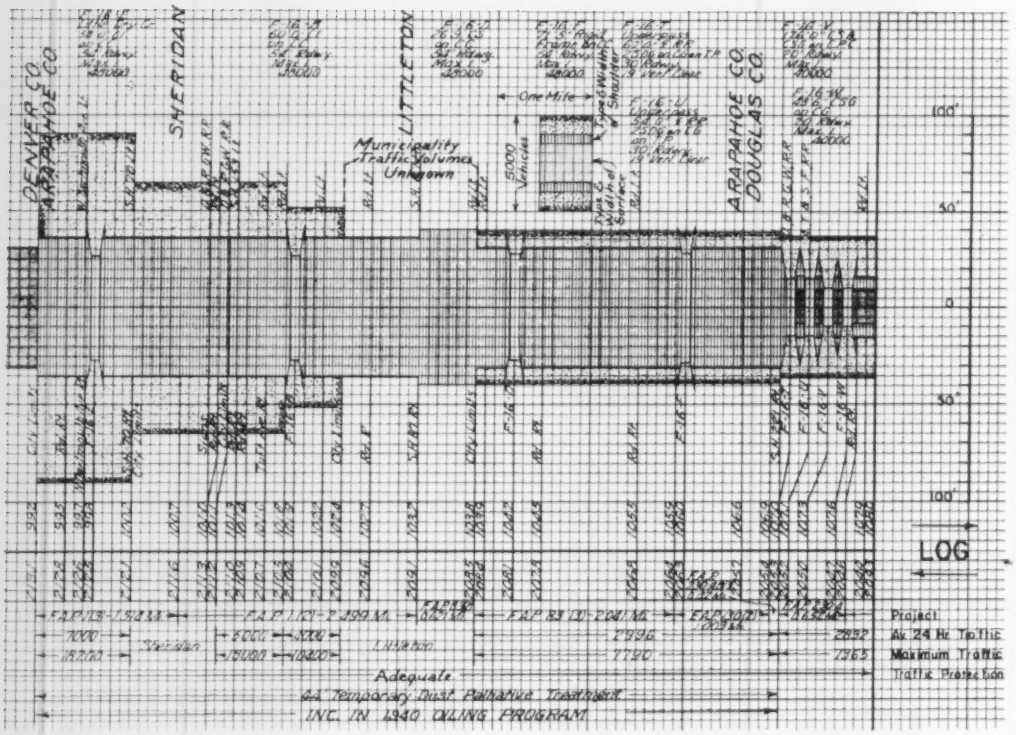


FIG. 3. PORTION OF A FEDERAL-AID ROUTE STATUS DIAGRAM

moving in the same direction—one going straight through, one making a left turn. The ratios of increase of this type in semi-urban and rural localities over urban localities are slightly over 2 to 1 and slightly less than 4 to 1, respectively.

Design details intended to reduce accidents at intersections include wider rights of way at intersections to increase sight distance; a sufficiently wide median parting strip between opposing lanes to permit turning vehicles to park between lanes until movement can be resumed without endangering other vehicles; and acceleration and deceleration lanes to provide lanes where traffic leaving the main highway can slow down for the turn, or where traffic can enter the highway and gain speed without danger of rear-end collisions. In cases of intersections involving heavy traffic flow on both highways, structures to separate this traffic are considered necessary. Also, the proper stop signs on secondary roads, warning signs, and pavement markings, are part of the requirements for correct intersection design.

The "between-intersection" diagrams forcibly emphasize contrasts between certain vehicle movements and the relative degree of safety with which each can be made within the various localities.

Angle parking in urban localities is the largest single contributing factor to two-vehicle collisions. In fact, in comparison with parallel parking, the expectancy of having an accident when backing from the curb in angle parking is better than $2^1/_2$ to 1 in urban localities (Fig. 1, lower left). On the other hand, in semi-urban and rural areas, movements forward and backward from parked positions are negligible in amount, and the ratios are about the same for each of these movements in both localities.

Two vehicles moving in the opposite direction involved in side-swipe crashes increase from 6.5% to 35.0% to 50.3%, or in the ratio of 1 to $5^1/_2$ to 8 in urban, semi-urban, and rural localities, respectively. Head-on collisions in like manner increase from 1.9% to 6.6% to 10.4%, or in the ratio of 1 to $3^1/_2$ to $5^1/_2$ in urban, semi-urban, and rural localities, respectively. The percentage increase of two-car collisions wherein one or both vehicles were on the wrong side of the road warrants careful study by the educator, engineer, and enforcement officer. Every effort should be made to keep the driver and his vehicle in the proper lane of traffic, on his side of the road. It is interesting to note here that the most prominent violation recorded in 1936, 1937, and 1938 was driving on the wrong side of the road in semi-urban and rural areas.

Also to be observed in the diagrams is the variation in the percentage of accidents involving vehicles entering or leaving an alley or driveway. The percentages of accidents contributed by these movements is 12.2%, 18.3%, and 7.3% in urban, semi-urban, and rural localities, respectively. Note should be taken that although cities have a preponderance of alleys and driveways, the percentage of accidents at such points is lower in cities than in semi-urban areas. This increase in semi-urban localities can be accounted for by the mushroom growth of small commercial establishments along the improved main-line highways, and by the greater speeds.

Design trends to combat between-intersection accidents include wider traffic lanes, a median parting strip to separate opposing traffic, wide shoulders and flat shoulder slopes, greater sight distance, and easier grades and curvature. Also along the more heavily traveled highways the need for service roads and limited access to the main route is becoming more evident.

The expanding needs of traffic make wider rights of way necessary. More than this, it is imperative that positive control of roadside improvements be exercised to prevent the promiscuous growth of hot-dog stands, beer joints, junk yards, fruit stands, dance halls, and so forth, where their presence would increase hazards to traffic. Many of the states have adopted zoning laws which permit this control, and it is expected that the application of these laws will result not only in a reduction in traffic hazards, but also in the general enhancement of property values along highways.

To illustrate another type of information now available for use in design studies, part of sheet No. 18 of "Federal-Aid Route Status Diagrams" is included herewith. It is one of 127 sheets covering the Federal-Aid System in Colorado and furnishing inventory data such as width and type of surfacing, shoulders and major structures, railroad crossings, road intersection and traffic volumes. This particular sheet covers the north-south highway adjacent to Denver and the portion reproduced here shows the new four-lane construction south of Denver where the heavier volumes of traffic exist.

A large reservoir of road information valuable in connection with highway design is being developed by the Highway Planning Survey. Without doubt, many future design trends will owe their adoption to facts gathered and so graphically presented by this agency.

Reconnaissance Surveys

A Variety of Methods to Serve a Multitude of Needs

By L. B. ROBERTS

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MANY are the uses and purposes of reconnaissance, for which engineers have evolved a number of surveying methods, each with modifications to suit particular circumstances. These Major Roberts describes briefly, buttressing his technical observations with illustrations from several continents. In essence the methods are simple but they do call for ingenuity, persistence, and hard work in their practical development. This article is abridged from a paper presented before the Surveying and Mapping Division at the Society's Spring Meeting in Kansas City.

EMPHASIS in surveying matters is being placed at present on greater accuracy, on improvements in establishing first-order control, and on methods of survey adjustments. Even a casual review of recent engineering publications indicates that considerable progress has been made in improvement of method but not in volume of production.

Reconnaissance covers a complete report of the essential information affecting a proposed undertaking. Surveys are often essential, and simplicity of method with ingenuity in its application is as important in reconnaissance as refinement is necessary in modern first-order surveys. Determinations of distance, of direction, and of difference of elevation of an area, are made. This is true even when the result is to be reported only orally, since boards of direction continue to take in more through the ear than through the eye. It will be desirable and usually helpful, however, to supplement the reconnaissance by recording the information obtained in map form.

WIDE RANGE IN PURPOSE AND ACCURACY

Such surveys have the widest possible range. The accuracy with which they are conducted differs greatly and the graphic representations of the journey vary from plain unadorned drawings to highly ornamented projected maps. Many travelers have submitted their first-hand knowledge of the areas they visited in the form of generalized reconnaissance maps; in the early days of this country, these clothed the skeleton of geographic knowledge of the great area in patchwork fashion, it is true, but they also served most helpfully when formal and more highly specialized maps were made.

Progress in surveying will be definitely retarded if methods become too much standardized, with special emphasis on any particular method. All methods should be taught and the one best fitted for the particular job should be adopted by the engineer. The survey will be, in each case, a special one, the specifications being determined by the person responsible for the proposed development who wants an answer only to the degree of accuracy which is required by his individual problem.

The reconnaissance survey is limited in every case by two factors: first, the amount of money allotted for it, and second, the time available. No other restrictions are placed on the engineer who is to do the job; there is always a method whereby he can accomplish the desired result.

The engineer charged with a reconnaissance should devote time to study and interpretation of existing maps. By all means, before undertaking even a rough survey, a search should be made for any information that may already be in existence. Reverting to the wide range of reconnaissance surveys—at one end of the line is the survey made with no instruments whatever. Quite rational traverses can be produced in this manner. Distance, on this type of work, is determined by pacing; it is assumed that every engineer knows, and will use, the length of his pace. A normal rate is 96 paces a minute at 30 in. a pace, or 2.7 miles per hour.

For angle determination, rough measurements may be taken with the hand at arms length. An angle of 15° is subtended by the span between the ends of the thumb and the middle finger—a most convenient angle since it corresponds to the value of the sun's travel in an hour. Practice in spanning the horizon is advisable; it is a convenience that a horizon is always available, both indoors and out. The horizon is also spanned 32 times by the distance between the forefinger and thumb, resulting in an angle of $11\frac{1}{4}°$, or one point of the compass.

Next in the ascending line of preliminary surveys, are traverses in which the pacing of an animal determines distance and a compass gives angles. I have had better success with mules than horses, as the mule is more steady, uphill and down, and continues to pace evenly at the end of a hard six-hour day. Such a traverse, 212 miles long, from the mountains north of the escarpment

SURVEY CARAVAN CROSSING THE BLUE NILE IN ETHIOPIA ABOUT 30 MILES FROM ITS SOURCE
Plane-Table Survey for Wagon Road Later Abandoned in Favor of Pacing by Mule

at Dessye, in Ethiopia, west and north across extremely rough country to Lake Tsana, when plotted on a scale of 4,000 ft to the inch, checked within $1^1/_2$ miles. The object of this reconnaissance was to determine the location of a wagon road.

Surveys of this type are frequently made by travelers. For example, Sir Francis Younghusband on a traverse of 1,255 miles by camel caravan in Outer Mongolia in 70 days checked with established points at both ends of

GRASSLAND TOPOGRAPHY NEAR EASTERN EDGE OF GOBI DESERT
Few of These Rounded Hilltops Could Be Used as Triangulation Points

the journey to a remarkable degree. The results of such purely reconnaissance surveys are reasonable and informative. A general reconnaissance of an area in advance of a systematic survey is always advisable. Even if the work is crude, the information will assist those who use it with a proper sense of its value.

Fairly good results for distance determination may be obtained by sound measurements. These are of particular value in densely wooded areas or in swamps where landings from boats are impossible. The best results are obtained by the regular firing of a gun at agreed-upon intervals, using 1,090 ft for each elapsed second in calm weather at 32 F. A correction of 12 ft faster for each 10° rise in temperature should be applied. A pendulum is as good as a watch in beating out seconds.

In more settled country, distance has been obtained with considerable success by rolling a wheel of known circumference over the ground. This method is used more extensively abroad. Where roads have been built in more developed areas, distances obtained by counting revolutions of a wagon wheel have proved adequate; in fact, this method seemed good enough for original land surveys. Strange as it may seem now, part of the original land sectionizing of the Middle West was carried out by this method; but those were the days when the contract surveyor was the monarch of all he surveyed. The roads shown on the standard topographic map of this country were traversed by plane table for direction and by wheel count for distance until about 1908; the results, plotted on a field scale of 4,000 ft to the inch, proved satisfactory.

On surveys where the determination of distance is made by stadia, it is advisable on reconnaissance to know how to stretch out the various sights. The commonest method is to add 4 ft to the length of the stadia rod by having the rodman hold the bottom of it at whichever button of his vest is just 4 ft above the ground. The following method taught me by French topographers has been found convenient: the telescope is rotated 90° so that the stadia wires are vertical. The rodman has two canes around each of which he ties a white cloth; using the rod to measure, he can stick the canes in the ground a rod's length apart, holding one end of the rod on the second cane. In effect, he has doubled the length of the rod; and it can be doubled once more by reading between the center cross-hair and one stadia wire.

It is also advisable on a preliminary survey to give some idea of the differences in elevation which produce the relief. Without instrumental determination of these differences, such information can be supplied only in the most general manner. If a picture of the relief will suffice, some form of hill shading or hachure work can be used to advantage, for this method continues to have a greater appeal than any other to most map users. To show the relief of an area in a convincing manner calls for real artistic ability. Abroad, this method is more generally accepted and in some schools is taught as true topographic mapping, the use of mathematical contours being a different subject.

Contouring is the best method yet contrived for showing the exact heights of an area. Next is the showing of relief by "form lines," interpolating what amounts to an entire contour system from a few spot heights. This takes practice and such practice is recommended.

For reconnaissance surveys of a still higher scale of accuracy, the engineer finds many aids, the various instruments being praised, criticized, or condemned by experienced engineers of equal authority. Direction, distance, and difference of elevation can be accurately and rapidly determined by the use of the plane table. Not the least of its advantages is its flexibility in operation. For example, as a member of the Third Asiatic Expedition of the American Museum of Natural History, I had to make a route survey on the Gobi Desert in Mongolia. On this level treeless country no system of triangulation or ground photography is possible, owing to a complete lack of recognizable points. The survey was to be made at maximum speed, to a definite scale and contour interval; and further, although not specified, it was desired that something better than aneroid barometer elevations be obtained. The entire party was to be transported in motor cars.

ADAPTING SPECIAL METHODS

To solve this problem, I decided to traverse the route taken by the main party, using the plane table for direct route recording, a solar chart for orientation, a car as a sighting point on which an angle could be taken with the telescopic alidade for differences in elevation, and the odometer of the car for distance. Two cars were used—one for the instrument, the other instead of a

A VIEW ON THE WESTERN EDGE OF THE GOBI DESERT NEAR THE ALTAI MOUNTAINS
Here Triangulation Was Possible and a Large Area Was Mapped by This Method

rod. An average of over 4 miles was obtained for each set-up, occupying alternate stations on the traverse; an average day's run was 51.3 miles, with a maximum of 72 miles. It was found possible to complete the elevation computations on the last sight while riding to the new position. The results were plotted on a scale of 1:200,000 or (about) 3 miles to the inch and were satisfactory as reconnaissance mapping.

SURVEY CAMP ON HIGHLANDS OF ETHIOPIA
Tents Arranged in Oblong Circuit for Protecting Stock Against Hyenas

This work was done in a treeless area. Where underbrush and thick jungle exist, it is possible to use a small plane table, 9 by 9 in., to advantage, with either an aneroid barometer or the small explorer's alidade for determining relief.

For obtaining differences of elevation, many types of instrument are available. Use of small hand levels is a guarantee of a long-drawn-out survey. Hand levels equipped with a clinometer give fair results when the area is not forested. The most popular and the most maligned instrument of all is the aneroid barometer. It is useful in obtaining differential elevations but quite unreliable for absolute ones. Simultaneous observations at two stations always give better results than those obtained by one traveler; all readings should be checked by a more precise method as soon as practicable. Nothing better, however, has been contrived for fast work than this instrument. When it is used with judgment, and a profound trust in the Lord, it will give fair results.

AREA SHOWING WIND EROSION, NEAR CENTER OF GOBI DESERT

Reconnaissance surveys of the most informative but not always the most rapid type are those made with area photographs, taken either from the ground or from the air. Such possibilities, although known to a few military engineers since 1850, became widely recognized during the World War. The theory and practice of mapping from the air has already been thoroughly discussed before the Society.

Mention of the aerocartograph, which produces work of the utmost refinement, may seem out of place in this paper; but it does have a definite bearing on reconnaissance mapping since any type of record that serves the particular purpose can be produced by such an instrument. For preliminary study and planning, the aerial photographs of an area can be viewed in a small stereoscope. The impression of distance thus gained, while only relative, permits a better interpretation of the topographical features of interest than could be obtained without such an instrument. It is necessary to establish ground control in the area to be mapped photographically if the reconnaissance report is to be supplemented by a controlled mosaic or aerial map. The problem is to determine the ratio of distances between image points on the photograph with the corresponding distances between these same points on the ground.

In Alaska, excellent results are being obtained by the U.S. Geological Survey in exploratory or reconnaissance surveys by the combined use of the plane table and the panoramic camera. This is in a mountainous region where the ranges consist of a complex arrangement of peaks, glaciers, and steep slopes—difficult country for ground work alone but a most favorable type for the camera method. Oblique aerial photographs are also used with the plane table on preliminary surveys in this area. The maps are usually on a scale of 1:180,000, or about 3 miles to the inch. Ground control, as usual, must be established in part of the area, and the prismatic astrolabe has been found an efficient instrument for this work. As the area is one of great rainfall—only 10 days a year are said to be suitable for aerial photographic work—the various operations are carried out independently, the aerial photographs being taken when weather permits. In the office, the map is produced by means of a panoramic photoalidade which permits the determination of the direction and the elevation of points in an oriented photograph.

VARIED USES FOR AERIAL RESULTS

At present interest in rapid aerial reconnaissance surveys is very great abroad; excellent results are reported to have been secured by the use of a solar periscope by the Italian military mapping services. On the film, at the same instant that the vertical exposure is made, the images of a chronometer, magnetic compass, and gyro-compass as well as the position of the sun are recorded. The practical result, in common with that of all exploratory surveys, is a map of small scale.

It should be noted, moreover, that aerial photographs have been used for many purposes besides mapping and in this sense are of particular value in reconnaissance problems. The clear photographic representation of the ground conditions has been used to demonstrate the character of settlement, communication, and geologic structure, as well as the possibility of the economic development of new countries or of city planning in old ones. From the map-maker's viewpoint, neither the aerial photograph nor the mosaic is a map; but engineers should realize that both the single view and the mosaic serve map purposes, especially in preliminary studies.

The following general suggestions may be helpful in planning reconnaissance surveys by ground methods. A principal valley, for example, characterized by gently

GREAT EXPANSE OF FLAT, TREELESS PLAIN CHARACTERIZES LARGE AREAS OF THE GOBI DESERT

rolling hills and subordinate valleys, lends itself to the development of a network of triangulation. Advantage should be taken of natural prominent points and the work based on a system of intersections. Angles of elevation to every one of these selected points should be a part of the work. The distance should be very closely observed where the vertical angle is large and the distance small; conversely, when the distance is great and the vertical angle small, it is the angle that must be closely observed.

If a reconnaissance survey is desired in very flat country, vertical control should be provided. Experience shows that errors of magnitude may occur if such work is not properly tied to proved level bench-marks. Where the main features of the area are broad valleys, the work should be conducted from the lowest parts to the highest. Also, endeavor should be made to cut across the drainage as often as possible. "Bone your math" is good advice to an engineering student; and "cut your drainage" is equally important in reconnaissance. When an area is examined along its characteristic lines, the special summits, the important gaps, and the ridges will be surely included in the investigation.

In areas where a heavily forested, high plateau region has been cut by subsequent drainage into ridges and hollows, information in regard to the ridges is usually difficult to get. Good results can be obtained by using the small plane table, compass orientation, aneroid barometer, and a linen tape 320 ft long. Stadia traverses are run on the main forks of the drainage system, cutting across gaps at intervals to form small blocks of the area. The ridge information is obtained from gap to gap, the aneroid barometer working well on the relatively small differences of elevation. For distance, the linen tape (which has been well soaked in paraffin) is pulled to its full length along the ridge by the rodman. He then shouts and the instrumentman, having oriented the plane table, draws a ray in the direction of the sound of the rodman's voice. Next he follows the tape to the rodman's station; taking the front end of the tape, he proceeds for another full tape length, orients the board, plots the position of the rodman as 300 ft, and locates the position of the new instrument station by backsighting on the sound of the rodman's voice. The rodman then follows the tape to the instrument and the operation is repeated until the ridge runs out at a gap previously located on the stadia traverse. The distance plotted for each tape length is 300 ft, as experience proved that 20 ft was the extra length needed in such country to take up the length of the winding course of the tape around the trees. I have used this method with success on scales up to 2,000 ft to the inch.

In the publication of a reconnaissance in map form, the engineer should bear in mind that the accuracy of a map bears a definite relation to the scale; he should insist that the proper evaluation be placed on the work and that the map bear this information on its face. If there is the slightest suspicion that the map will be enlarged and used for design or location, only an immediate resignation will forestall certain loss of reputation. A map projection will not be necessary unless the area is much in excess of ten square miles.

That the same standard of accuracy be maintained throughout a reconnaissance map is not essential; in fact in many cases it is not possible to complete the work in that manner. For example, I have seen maps produced for military purposes where part of the area was held by the enemy; these maps had an extreme accuracy to the rear of the front lines, certainly a diminished accuracy near them, and only a few intersections in enemy territory. Such maps bore the unique legend, "Every point on this map is wrong." A good example of a standard map having different standards of accuracy is found in the official maps of Switzerland—the valley areas are shown in useful contours and the alpine areas by hill shading.

Map style and ornamentation have reached a decidedly formal stage in the standard issues; the writing on the map is regarded in some quarters as a map symbol in itself; serious discussion is held as to whether alphabets should or should not carry serifs. Similar consideration is shown by permanent committees on geographical names to the authorized spelling and the transliteration of foreign place names. In the recording of reconnaissance surveys, it is sufficient that the writing be as simple and legible as possible and that place names be recorded as heard.

The methods by which reconnaissance can be made are essentially simple ones and call for nothing more than ingenuity, persistence, and hard work in their application. Famous reconnaissance surveys of the past have been made by a splendid company of men. Since "good men follow the good men gone" we have an assurance that when need arises, work equally adequate will result.

TYPICAL GOBI DESERT TOPOGRAPHY
Triangulation Was Not Possible and a Car Was Used as a Stadia Rod in This Area

Seattle's Henderson Street Sewage Treatment Plant

By M. O. Sylliaasen

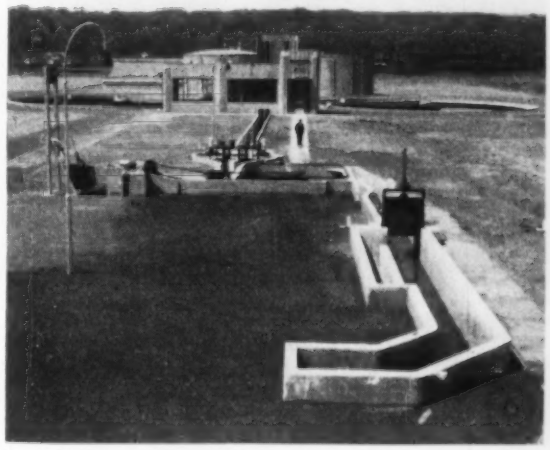
Member American Society of Civil Engineers

Consulting Engineer, Seattle, Wash.

THERE has just been completed and placed in operation a sewage treatment plant serving a population of 30,000 in the southern part of the city of Seattle. Primary treatment only is attempted, with discharge into tidewater. Provisions for enlargement, as required by future demands, have been included. Mr. Sylliaasen here describes the development of the project, its arrangement, and mode of operation.

A SEWAGE treatment plant serving a small portion of the city of Seattle has recently been completed and placed in operation. It is the first such plant in the city except for three small Imhoff installations, two of which are no longer in operation.

Seattle lies between Lake Washington and Puget Sound (Fig. 1). The city is sewered by a combined storm and sanitary system, designed in the residential areas to care for 1 in. of rainfall per hour with 25% runoff. During periods of maximum runoff a portion of the flow in the trunk sewers is allowed to overflow into various lakes and waterways at convenient locations.



General View of Plant from Pump Chamber Roof

Approximately the north half of the city is served by the North Trunk Sewer (Fig. 1), which has an outfall at an excellent location on Puget Sound, where the currents are offshore regardless of wind or tide. Treatment of this sewage will probably never be necessary. The remainder of the city is served by many smaller sewers, also with outfalls along the shore of Puget Sound and in the Duwamish River Waterway which is tributary to the Sound. The flow from these sewers will require other disposition in the future and the new Henderson Street treatment plant is the first step in this direction. The plant is located on a tract of 17 acres on the Duwamish Waterway and handles the bulk of the flow which previously reached the waterway untreated.

Prior to 1926, thirty-two small sewers had their outfalls in Lake Washington. A bond issue of $2,125,000 was then voted to divert all sewage flow from the lake. From time to time interceptors have been built and pumping plants installed, diverting part of the flow to the North Trunk Sewer and the Hanford Street Trunk Sewer and the remainder to the Henderson Street Trunk Sewer, which has its outfall in the Duwamish River. The 1926 bond ordinance specified that the sewage brought to the river from the Lake Washington basin be treated before discharge. The Henderson Street plant fulfills this mandate and in addition cares for most of the flow from the Duwamish River basin.

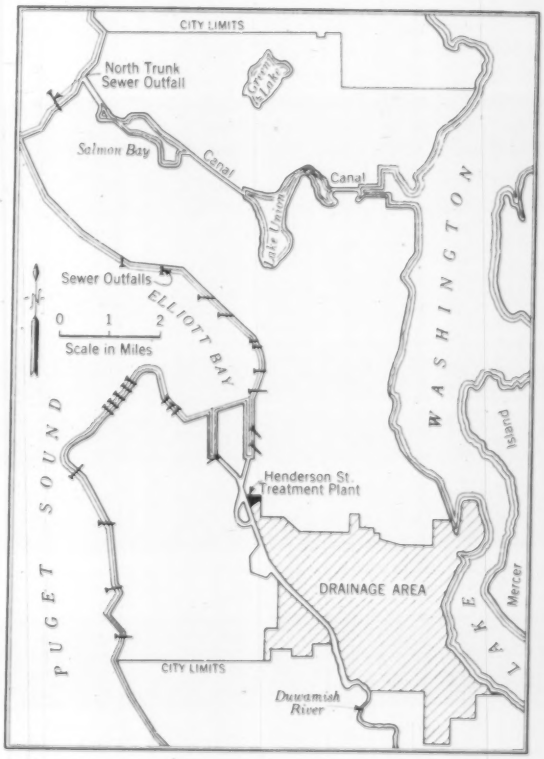
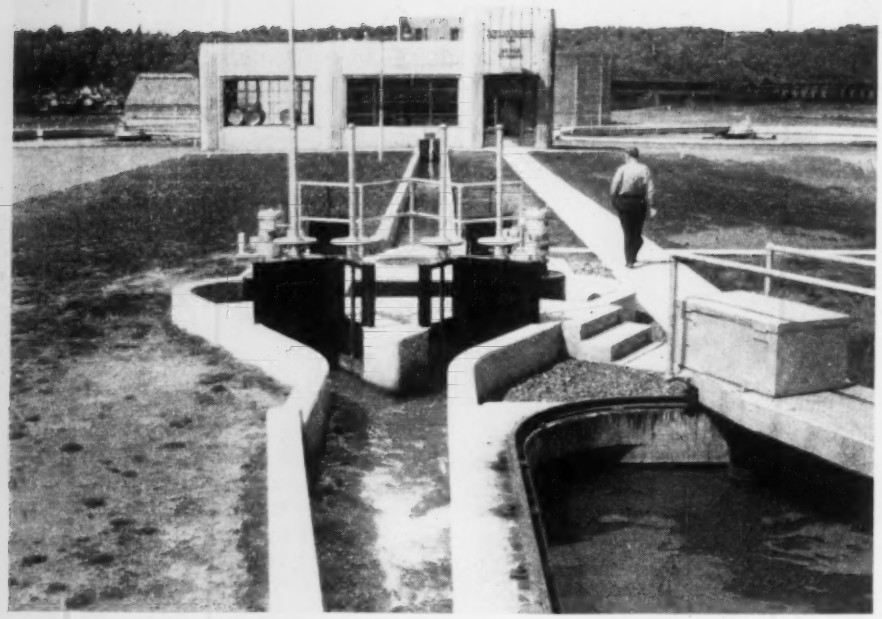


Fig. 1. Map of Seattle Showing Location of Henderson Street Treatment Plant

The treatment plant is designed to serve a population of 32,000 and a flow of 8,000,000 mgd from a sparsely populated area. As the Duwamish River water is not used for drinking, bathing, or industrial purposes, and as the plant is intended merely to eliminate visible nuisance and odor, and to protect commercial and game fish, it was determined that primary treatment only was required at the present time. Ease and economy in operation, certainty of results, and opportunity for ready disposal of dried sludge pointed to the selection of a plant providing grit removal, plain sedimentation, two-stage sludge digestion, and sludge drying beds.

A high ground-water level at the site made it advisable to select a type of plant utilizing tanks that would not extend to great depths into the ground. The plant site is of sufficient size to accommodate additional units and a more complete treatment as required. The location is such that intercepting sewers diverting all sewage from the main waterfront on Elliot Bay can reach the plant.

Sewage follows the paths shown diagrammatically in Fig. 2. It enters through an overflow chamber, where excess flow, or the entire flow if need be, can be diverted through a 30-in. sewer to the river. Passing the overflow chamber, it next enters the pumping plant, where three 2,800-gpm float-controlled pumps lift it 29 ft. Thence it flows by gravity through the plant. One pump is intended for standby use only. From the pump discharge a concrete flume leads past an emergency overflow weir to a Parshall measuring flume, which is con-



DETRITOR AND COMMINUTORS—PLANT CONTROL HOUSE BEYOND

nected to a flow-recording gage in the control house. These arrangements are shown in Fig. 2.

Grit is removed by a detritor with a 13-ft width of weir, a 2-ft water depth, and an inclined trough up which the grit is raked and washed, thereby eliminating the odor and nuisance so often present in such material. The rake deposits the grit in a steel bucket equipped with a chain hoist for direct loading into a truck. Ultimate disposal of the grit is by filling on the site, much of which is low ground.

From the detritor the sewage flows through two 25-in. comminutors. These devices consist of vertical-axis, motor-driven cylinders suspended in the flow channels. The sewage flows through $^3/_8$-in. horizontal slots in the cylinders. Particles not passing through are ground up against vertical cutters with teeth engaging the horizontal slots. The screening and grinding of screenings are both performed under the surface of the sewage flow without nuisance. Each comminutor will pass 4 mgd with a head loss of 4 in.; or 8 mgd with a head loss of 10 in.

FUNCTIONS OF CONTROL HOUSE

Open concrete channels carry the flow into the control house, from which it goes to either or both of the sedimentation basins. On the main floor of the control house are a laboratory room, a wash room, a locker room, an operation control room, and a chlorine room equipped with two vacuum, solution-feed, manual-controlled chlorinators, each with a capacity of 500 lb per day. Chlorine may be applied to the clarifier influent or effluent and will be used only during periods of low flow in the river. Adjoining the chlorine room is a rack for five one-ton chlorine cylinders and a scale showing the amount and rate of flow. In the basement of the control house are a gas-fired water heater burning digester gas or commercial gas, two 4,200-gal per hr sludge pumps, and one dewatering pump.

The two sedimentation basins are radial-flow clarifiers, 85 ft in diameter by 11 ft 3 in. deep, with sludge rakes and surface skimmers. They are designed for 2-hour detention and provide 1 sq ft of surface area per 700 gal per day of flow. The effluent flowing over the circular weir is carried to the main plant by-pass and discharges into the waterway. The scum is washed from the scum trough to a scum sump in the control house and pumped at intervals to the digesters.

Next in sequence are the digesters. The primary digester is 40 ft in diameter, 20 ft high, and is equipped with a heat diffuser with heat control up to 90° and a turbo-mixer for intimate mixing and circulation of the contents. The mixer quickly seeds incoming sludge with digested sludge, aids in maintaining a uniform temperature by circulating the sludge around the heat exchanger, and prevents the formation of heavy scum. The more rapid digestion produced by these ideal conditions increases the gas production. The primary digester is designed to allow for 20-day storage of sludge containing 95% water. The partially digested sludge flows by gravity to the secondary digester.

PROCESSES IN DIGESTION

This secondary digester is of the same size and is of the non-mechanical, non-heated type. The contents become stratified into two layers, an upper layer of supernatant liquor which is clear and well settled, and a lower layer of dense, well-thickened sludge which can be drawn off with a minimum of water content. The secondary digester is equipped with a floating steel dome serving as a gas holder, and is designed to provide for 70-day storage of sludge with an average water content of 89%. The supernatant liquor flows back to the sewage channel entering the plant control house.

Joining the two digesters together is a digester control house, in which are located gas piping, gas meters and safety devices, sludge piping, sludge observation sumps, and sampling pipes. Exterior insulation walls on the

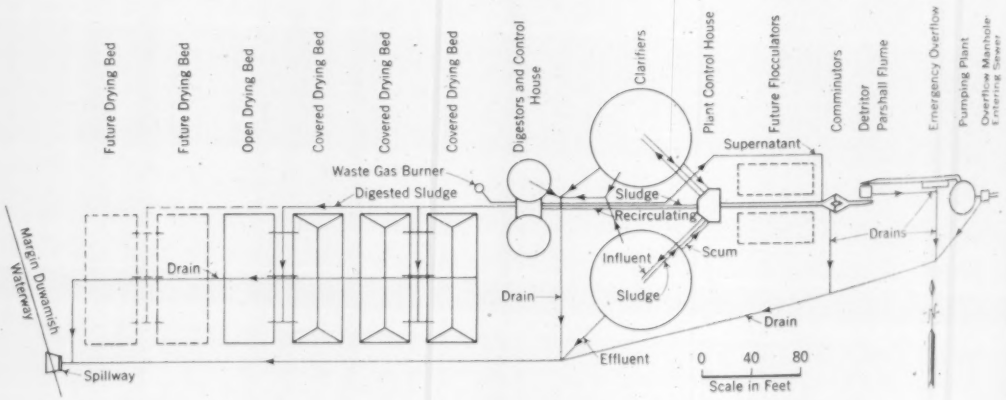
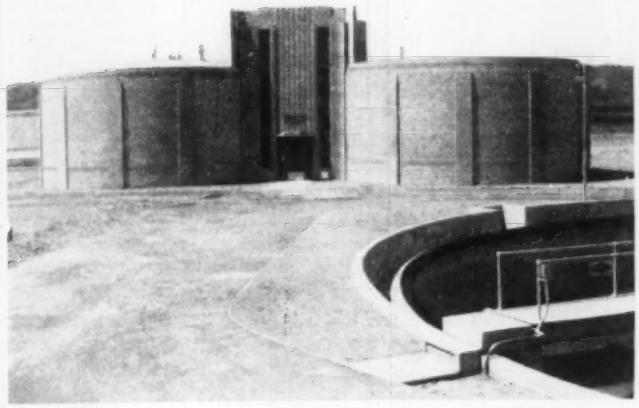


FIG. 2. SKETCH PLAN OF ENTIRE PROJECT FOR SEWAGE TREATMENT

two digesters are of concrete brick separated from the main tank walls by a $4\frac{1}{2}$-in. air space.

Digester gas is used for heating the primary digester, the plant control house, and the digester control house. The excess is burned in a waste gas burner located just outside the digester control house.

The digested sludge will be drawn off by gravity to four sand beds 40 by 100 ft, three of which are glass covered, to facilitate drying during periods of inclement weather. As the flow approaches the design quantity,

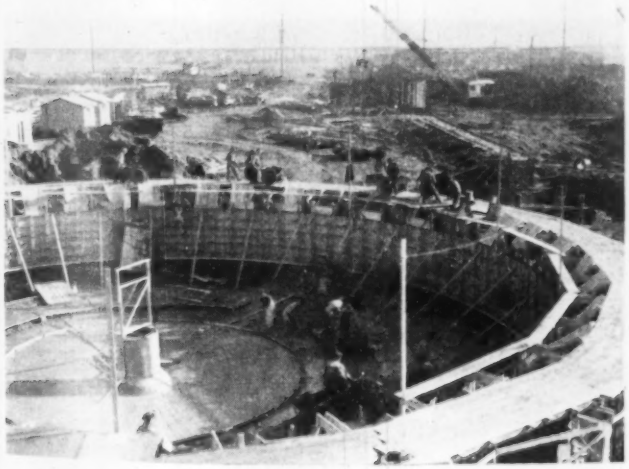


DIGESTER GROUP, AND PART OF CLARIFIER AT RIGHT

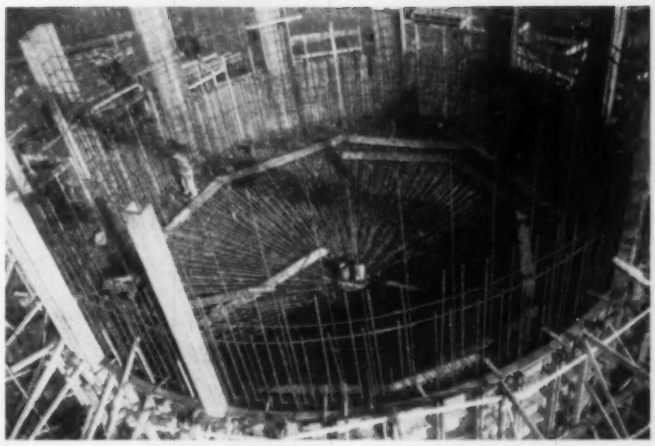
it is expected that two sand beds will be added and all will be glass covered. Provision is made for mechanical ventilation of sludge-drying houses if this is found to be necessary. Dried sludge will be loaded by hand onto a caterpillar tractor with side saddles and used for fill on the site or as a soil conditioner.

Provision was made in the design for two 21-ft by 53-ft flocculator tanks, which when built will greatly increase the percentage of removal of suspended and semi-colloidal solids by the clarifiers.

As the photographs indicate, considerable thought was given to pleasing appearance in laying out the plant, it being felt that everything possible should be done to engender a friendly attitude on the part of the public. The two highest structures—the plant control house and the digester group—are on the plant center line and are given modernistic architectural treatment.



CLARIFIER FORMS AND CONCRETING



DIGESTER FORMS AND REINFORCING

The site was developed by hydraulic fill overlying uncertain river-bottom mud, with a ground-water level as high as El. +2.0, or just 6 ft below the clarifier weirs. All structures are of reinforced concrete, and all are supported on timber piling except the pump chamber, which because of its greater depth bears on a firm stratum at that level. All structures extending below El. +2.0 are designed for uplift, with the excess over dead weight taken by the piling.

For all liquid containers the maximum concrete stress in bending was limited to 750 lb per sq in.; the steel stress in bending, to 12,000 lb per sq in.; and the steel stress in direct tension, to 10,000 lb per sq in. For all other structures the permissible concrete stress was 1,000 lb per sq in. and the steel stress, 16,000 lb per sq in.

SOME CONSTRUCTION FEATURES

All concrete surfaces above ground and all surfaces in contact with liquor were poured against plywood forms, care being taken to obtain smooth surfaces and dense concrete. The mortar finish on the sloping floors of the clarifiers was spread accurately by means of the sweeping mechanism with temporary screeds attached.

Total cost of the plant, including engineering charges, was $323,000. In this total is also included the cost of 400 ft of 60-in. sewer leading in from the adjoining street, 2,200 ft of 12-in. water main, and 500 ft of 8-in. water main, a permanent fence around the property, and the necessary fill on the site. The funds came from a sewer bond issue augmented by a PWA grant.

The plant design and detailed designs were checked and approved by Roy M. Harris, Assoc. M. Am. Soc. C.E., chief engineer of the State Department of Health, and by C. C. Hockley, Assoc. M. Am. Soc. C.E., regional director of the PWA. The work was instituted under N. A. Carle, M. Am. Soc. C.E., city engineer, and built and brought into operation under C. L. Wartelle, city engineer. The design drawings and specifications were made under the direction of J. H. Quense, chief draftsman in the city engineer's office, and the writer served as consulting engineer. The General Construction Company, with C. W. Fitton in charge, built the entire plant, and their painstaking care, together with that of the equipment manufacturers and the city inspectors, resulted in an excellent piece of work.

The plant is being operated under the supervision of W. P. McNamara, sewer maintenance engineer under the city engineer. All equipment is operating in a satisfactory manner, but since the present load is far below the design flow the sludge is building up slowly and the secondary digester is not yet filled.

Development and Maintenance of a Navigable Channel in the Missouri River

By DANIEL R. NEFF

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SINCE "Civil Engineering" last carried an article on the Missouri River improvement project, the work has been going steadily forward, to the accompaniment of numerous modifications in technique and structures. This progress is here described by Mr. Neff in an abridgement of his paper before the Waterways Division at the 1940 Spring Meeting. Of particular interest is his account of cutoff construction, the trend toward lighter structures, and the development of asphalt revetment and rock and earth-fill chute closure dams. The opinions expressed here are those of the author and do not necessarily reflect the official views of the U.S. Engineer Department.

IN 1912, Congress authorized improvement to secure a permanent navigable channel in the Missouri River, with a minimum depth of 6 ft and a minimum width of 200 ft, from the mouth to Kansas City, and in 1927 this authority was extended to cover the development of a similar channel between Kansas City and Sioux City, Iowa. Large-scale construction began in 1928, and regulating works are now approximately 85% complete as far upstream as Blair, Nebr. (near Omaha), and 65% complete above that point. At present, further work is under way at all locations where a channel of project dimensions has not yet been developed. Methods and structures employed in the control operations were described in the July 1936 issue of CIVIL ENGINEERING by Capt. Orville E. Walsh, at that time assistant to the Division Engineer, Missouri River Division. To avoid duplication, I will devote the major portion of the present paper to the more recent developments in thought and engineering practices involved in the work.

Discharge of the Missouri River at Kansas City varies from a minimum of approximately 6,000 cu ft per sec to a mean high-water discharge of approximately 142,000 cu ft per sec, with a maximum recorded discharge of approximately 548,000 cu ft per sec. The maximum potential (design) flood at Kansas City is 540,000 cu ft per sec, with reservoir control in the Kansas basin (700,000 cu ft per sec without such control). The river is one of the greatest silt carriers in the world, the average annual silt discharge at Kansas City during the most recent period of record being 397,700,000 tons, and the average concentration of silt, 4,780 ppm. The section under improvement is characterized by a remarkable uniformity of slope, which averages approximately 0.9 ft per mile. However, there is considerable variation in local slopes, from a minimum of 0.3 ft per mile to a maximum of 1.6 ft. Physical and hydraulic characteristics of the Missouri River dictated the selection of open-channel regulation as the only method that would hold possibilities for successfully developing its channel at reasonable cost. In addition to such channel regulation, however, it was evident from the meager flows often encountered during the fall months that supplementary reservoir storage would be required. These two coordinated factors are incorporated in the present comprehensive channel-improvement program.

The primary theory of channel development on the Missouri River has been one of shaping, rather than of contraction as such. The endeavor has been to so shape the thalweg that the river will, under all conditions and at all points, retain sufficient controlled energy to scour a satisfactory channel. The secondary theory, little less important than the first, is that the high-water thalweg must coincide, as far as practicable, with the low-water thalweg.

In its natural state the river wanders between rather low, easily erodible banks in numerous small streams, separated by continually shifting sand bars and islands. The objective of successful open-channel regulation is to mold this shapeless, unstable river into smooth bends of proper radius, to concentrate the hydraulic energy along the concave banks, and so to direct the flow at crossings that a navigable channel will be continually scoured through the normal crossing bars. It has been determined that the curvature of individual bends should decrease from head to foot, approximating an open spiral, and that the bends should have a minimum radius of 4,000 ft, or preferably 5,000, and a maximum radius increasing from 8,000 ft at Sioux City to 20,000 ft at the mouth. The desirable radius of bends varies roughly with the volume of flow. It is necessary to realign all improperly shaped bends found in the natural river, and to introduce long sweeping sinusoidal bends in the place of natural unstable reaches.

For many years, studies were made to determine the proper clear channel width between structures on opposite sides of the river. This width must be predicated on three basic considerations: first, flood heights must not be raised; second, natural velocities must not be unduly increased; and third, the flow must be sufficiently confined to prevent serious low-water meanders within the limits fixed by the control works. Experience indicates that a clear width of 800 ft at Sioux City, widening by increments at the junctions with large tributaries up to 1,100 ft at the mouth, will provide a channel of adequate depth without adversely affecting flood heights or natural velocities.

The shaping process is carried out by constructing two basic types of control works: permeable pile clump or crib dikes to shape the river into the desired alinement; and revetments to protect the concave banks from further erosion once the desired shape has been attained. The details of these dikes and revetments have been fully described in the paper by Captain Walsh.

Dikes are considered to be only a means toward an end; they are used primarily to shape the river to the designed trace, and to form new banks on the desired alinement. These results are due to the slight retardation of the current by the open clumps, which causes a deposit of sediment to form downstream from each dike in the system. This deposit is built higher with each succeeding high water, until it reaches a height of approximately 4 ft above mean low water. Then a luxuriant willow growth springs up, and the additional current retardation caused by these willows increases the rate of sedimentation, so that in from three to eight years the dikes

are almost buried, and the desired new banks have been formed. During this period the increased velocities at the dike ends cause rapid erosion of the opposite banks. This erosion is permitted to proceed unchecked until the proper curvature and alinement have been obtained, at which time the concave bank is revetted.

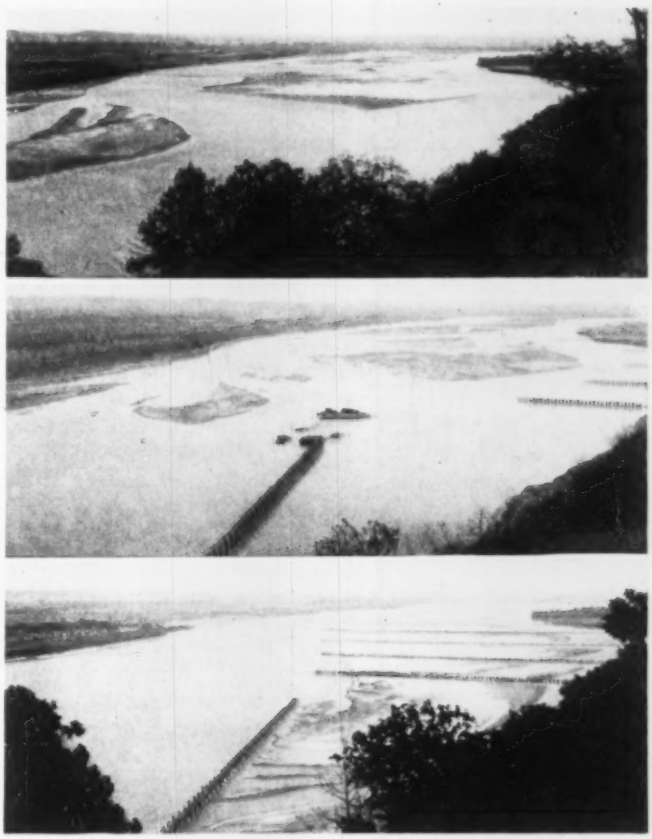
Construction of control works will not alone develop a channel with the desired dimensions. Such a result will eventuate only if the minimum flows are adequate to keep the channel scoured out. The minimum flow necessary to accomplish this result is now considered to be approximately 25,000 cu ft per sec at Sioux City, which with minimum pickup corresponds to approximately 29,500 cu ft per sec at the mouth. In order to provide storage for augmenting the natural low-water flows, the Fort Peck Dam is now being constructed. Detailed studies of a 50-year period of record indicate that its 19,600,000-acre-ft reservoir will fill in from eight to ten years. During this filling period, however, partial river regulation, gradually increasing to full regulation, can be undertaken. Thus it is expected that between 2,000,000 and 3,000,000 acre-ft will be available to augment low flows of the late summer and fall during the present year.

RECENT DEVELOPMENTS IN TECHNIQUE AND STRUCTURES

Cutoffs. In the past every effort has been made to prevent natural cutoffs in the section of river under improvement, because of the expected serious upsets in river regimen, and the construction of artificial cutoffs has been avoided. Nevertheless, difficulties in developing a satisfactory channel by orthodox methods in that section immediately upstream from the mouth of the Platte River led to consideration in 1937 of the feasibility of constructing a cutoff in that vicinity. Detailed studies of this section indicated that abnormal slope conditions prevailed, characterized by the unusually flat slope of 0.3 ft per mile above the mouth of the Platte, combined with an unusually steep slope of 1.3 ft per mile below the mouth of the Platte. These local variations in slope were caused by the deposition, in the Missouri, of large volumes of heavy gravel brought in by the Platte. The lower Platte has a slope of 4.6 ft per mile, which renders it capable of transporting material which the Missouri cannot immediately remove. A short distance upstream from the mouth of the Platte the Missouri River looped in a long bend of undesirable shape and curvature (St. Marys Bend). It became apparent that if the Missouri River could be shortened by cutting across the neck of St. Marys Bend, without seriously upsetting the river's regimen elsewhere, a more desirable curvature would be obtained and the abnormal slopes above and below the mouth of the Platte would be equalized. This would cause the available energy of the Missouri to be increased to the point where it could carry downstream the large sediment deposits brought in by the Platte.

Accordingly, during the winter and spring of 1938, a pilot channel was dug with draglines within the designed trace of the new channel to a depth of approximately 8 ft below mean low water, and to a width varying from 80 to 125 ft. The designed trace shortened the natural thalweg 4.2 miles, and the calculated head at the mouth of the cut was 3.7 ft. The upstream plug was opened early in the spring of 1938; development of the initial cut was rapid, and velocities, rather high at first, returned almost to normal within a month. At present the old channel is practically filled, and the new channel has developed to adequate dimensions and to correct alinement. The results so far have been fully up to the original expectations. Subsequent to opening the pilot cut, a pile clump dike was driven across the old channel in such a manner as to direct the river into the mouth of the cutoff.

Since construction of this initial cutoff, nine pilot channels have been dug between Sioux City and Kansas City, and several more are now under construction, or contemplated, between Kansas City and the mouth. Observation of sections of river completed in this manner indicates that the desired results have been accomplished at a more economical over-all cost, and with an estimated shortening of the construction period of from one to three years.



A TWO-YEAR TRANSFORMATION

Top: Unimproved River, with Shallow, Meandering Channel and Eroding Banks. Middle: One Year Later—Dikes Under Construction. Bottom: The Next Year—Dikes Finished, Accreted Land Forming, and a 6-Ft Navigable Channel

Trend Toward Longitudinal Dikes. Based on considerations of initial economy, it has been the past practice on the Missouri River to accomplish the greater portion of river shaping with dikes placed normal or inclined slightly downstream with respect to the current. When properly placed in systems, such dikes were known to produce the maximum movement of the channel per foot of length, and were, and still are, absolutely necessary when effecting radical channel changes in unimproved sections. However, as the river has become stabilized, it has been found that further refinements of design can be accomplished more economically through the construction of longitudinal dikes, driven along the desired bank alinement. It is the present thought of those directing the improvement that all concave banks of the finally completed channel should be protected with revetments constructed to smooth alinements. Longitudinal dikes form new banks more readily adaptable to this subsequent protection than do spur dikes, which create a rather "scalloped" bank line with bays from 100 to 200 ft in depth between the structures.

Trend Toward Lighter Structures. Considerable study has lately been directed toward determining the minimum strength to which channel-shaping works can be constructed without detracting seriously from their effectiveness. Starting initially with 3-row and 4-row pile-clump dikes with individual clumps driven on 18-ft centers and braced, in many instances, with an additional row of clumps, lighter structures have been progressively developed. The great strength of the initial structural types was necessary to accomplish the radical primary shaping of the uncontrolled river. However, as the channel has become stabilized, and the attack upon channel-control structures has consequently decreased, it has been found feasible to effect considerable changes in the channel alinement with 2-row single-pile longitudinal dikes driven on the desired channel alinement. In several instances such dikes have been effective even though unbuttressed by spur or baffle dikes.

Further study and experimental construction have more recently demonstrated the feasibility of utilizing the foundation mattress of longitudinal dikes for the additional purpose of inducing a more rapid fill. This is accomplished by suspending the inshore section of the mattress on the desired under-water slope (1 on 3) from the dike stringers in shallow water, or in deeper water from subsidiary pile bents driven landward from the dike proper. It is believed that, if such structures are built early in the spring when there is no further danger of ice damage, a sufficient fill will normally be acquired during the spring and summer high-water periods to afford protection from serious damage during the succeeding spring ice run. Experience to date indicates that this form of construction will result in considerable initial economy when used in carefully selected locations.

Asphalt Revetment. Although rock suitable for constructing standard revetment is found adjacent to the Missouri River in all localities downstream from Rulo, Nebr., suitable rock becomes increasingly scarce and correspondingly more costly upstream from that point. This fact, coupled with objections to the use, under certain conditions, of the board mattress that is also a part of the standard revetment, led recently to the investigation of other possible types. As a result the District Engineer at Omaha, working in close cooperation with the engineers on the lower Mississippi River and assisted by the experts of the asphalt industry, has developed a reinforced asphalt bank protection which holds great promise for furnishing superior bank protection at considerably less cost than standard rock revetment.

The new revetment consists of a compacted, reinforced, asphalt mattress $1^3/_4$ in. thick, for under-water bank protection, combined with a compacted, upper-bank asphalt paving $2^3/_4$ in. thick, reinforced for approximately half the distance up the bank. The mattress is anchored with either piles or screw anchors, and the upper-bank paving is anchored to screw anchors or deadmen firmly imbedded in the river bank. The reinforcing consists of 2 by 4-in., 12-gage galvanized wire mesh, placed in the center of the mattress and paving, additionally reinforced with longitudinal and transverse galvanized cables $^9/_{32}$ and $^3/_8$ in. in diameter. Stainless steel is used for the exposed cables.

Aggregates used in the asphalt mix are loess and sand, both of which are found in unlimited quantities in, and adjacent to, the Missouri River. These materials are mixed hot with a petroleum asphalt binder which is closely specified as to physical and chemical properties. The plant for mixing and placing this material was developed on the job. So far, 20,000 lin ft of this type of revetment has been constructed in the Omaha District, and some of it is now approximately two years old. Although a few failures, particularly in the initial experimental type, have been experienced, they are minor in character and indicate no basic flaws in this type of revetment. Based on the rather limited experience to date, asphalt revetment appears to be superior to rock revetment with board mattress under-water protection, and fully as satisfactory as rock revetment with willow mattress under-water protection. Based on the costs of the more recently constructed sections, it can be built for from $3 to $5 per lin. ft less than the standard types.

Rock or Earth-Fill Chute Closure Dams. During the final phases of channel development, new banks are built up within the limits of dike systems. However, in some cases, particularly when an existing island is included within the limits of effect of a dike system, shore chutes persist long after stabilization of the channel is otherwise complete. These chutes upset the river regimen both by depleting the water in the primary channel and by causing bars to form at their point of reentry into the main channel. In order to effect permanent closure of these chutes, the dikes at their head were at first screened with willow mats. This was not entirely effective. Then brush-filled cribs were constructed in some chutes. The shorter path and greater velocity through the chute, however, operated to defeat the purpose of these permeable structures, and as their effective age limit approached, it became necessary to evolve some positive means of closure, if replacement of the exposed dikes was to be avoided. Two structural types have been developed and have proved effective for this purpose: one, a rock-fill impermeable dam placed on a heavy willow fascine mattress; the other, an impermeable paved earth fill. These dams are designed either with a crest elevation above maximum high water, in which case only the upstream face of the earth fill is paved, or with a crest elevation which will be overtopped by high water, in which case both sides are paved. Both types have been successful in inducing rapid filling of chutes. If properly designed, little damage results when these low dams are overtopped, as the head differential is slight.

MAINTENANCE OF THE NAVIGABLE CHANNEL

The problem of maintaining a navigable channel divides naturally into two parts, the first being the direct maintenance of the channel itself and the second the maintenance of the control structures as such.

Channel Maintenance. The present thought is that channel regulation should be carried forward by means of further refinements of design, to the point where no maintenance dredging will be required. At present there are still five dust-pan type suction dredges assigned to work in the Missouri River Division. However, with stabilization of the low-water flows about a fixed minimum by operation of the Fort Peck Reservoir, and with the continuous advance in channel regulation as new works become fully effective, it is planned to gradually retire these dredges from service over the next few years. The large savings in maintenance expenditures that will thus be realized will more than offset the increased capital charges for the construction and maintenance of the additional control works.

Between Kansas City and the mouth, the channel is marked with buoys, permanent timber channel markers, and lights. Buoys are used to define the minor variations in channel alinement, particularly at crossings. Timber channel markers, usually in the shape of white crosses and lighted for night operation, are used to define the general channel alinement. The buoying, marking, and lighting is at present a joint project of the U.S. Light-

PETERSON BEND CUTOFF, FOUR MONTHS AFTER COMPLETION OF DREDGED PILOT CHANNEL
Note That Degradation of the Old Channel Is Already Nearly Complete

house Service (now a part of the Coast Guard), and the Corps of Engineers; however, it is contemplated that the Lighthouse Service will gradually take over this work as funds are made available to it.

Maintenance of Structures. Structure maintenance is gradually becoming an important problem, for it is now apparent that the average effective life of the exposed portions of pile structures in the Missouri River is from 10 to 16 years, depending on the type of timber used. Although most of the woods native to the South and Far West have been used to some extent on the river, pine, fir, and cypress constitute the greater portion. Soft pine has proved to be the most susceptible to deterioration, while cypress and fir have proved to be the most durable, and as a consequence are now used almost exclusively. Although only the small portion of the structure which is above the permanent water surface deteriorates, this portion is generally the most important in maintaining satisfactory channel conditions, particularly in the case of dikes located on the concave side of bends.

Many structures are now approaching the limit of their effective age, and serious consideration is being given to their repair or replacement with more permanent structural types. It is now believed that reasonable costs for the maintenance of either the navigation channel or the control structures can only be achieved by working towards a river which will eventually have all concave banks revetted. Where the concave side of a bend has been formed initially with dikes, it appears desirable to construct rock revetment on the desired alinement prior to the expiration of the effective life of the piling, in lieu of maintaining the dikes indefinitely. Where it is apparent that the fills will not accrete to sufficient height, or will not be sufficiently stable to revet within the effective life period of the structures, it is considered good practice to accelerate the deposition of fill by means of dredging.

While structures on the concave side of bends are subjected to continuous attack, there is little or no attack on the structures on the convex side, once the river has been properly shaped. As a consequence, such structures need little maintenance, for normally they have served their purpose by the time deterioration becomes serious.

During the construction period, and for several years thereafter, while the channel is not yet completely stabilized, ice movements cause considerable damage to dike structures. However, when considered in relation to the cost of the entire project, such damage has never reached serious proportions; moreover experience has shown that comparatively little ice damage is incurred after the river has become completely stabilized.

Concurrent with the development of a navigable channel, comprehensive studies have been undertaken to determine the effect of regulating works on the physical and hydraulic characteristics of the stream. Particular study has been directed toward determining the effect of open-channel regulation on flood heights. All facts thus far assembled point to the conclusion that a greater volume of water will be carried below bank-full stages by the improved channel than has heretofore been carried by the unimproved channel. Many factors help to account for this; mainly, however, it follows from concentrating the flow in one unimpeded channel with a greater hydraulic radius, providing smoother flow conditions in the long sweeping bends, and eliminating all sharp changes in direction. During extreme floods, when there is considerable over-bank flow, it is considered that flood heights will not be adversely affected. In fact, studies now incomplete indicate a tendency toward improved discharge characteristics even under these extreme conditions. Moreover, apart from the channel regulating works, the Fort Peck reservoir will normally operate to reduce the height of major floods.

In the absence of large-scale flood protection measures, the Missouri River valley will always be subject to overflow during periods of extreme runoff. Nevertheless, it is apparent that by increasing the capacity of the channel below bank-full stages, the improvement project will reduce the number and duration of overflows.

Although accurate evaluation of the effect of channel regulation on the slope and silt-transporting characteristics of the river has so far been obscured by local disturbances of regimen resulting from new construction work, it is believed that these functions will be little changed. Conditions of uniform slope stability were plainly evident in the river when improvement was begun, and these stable conditions have not been upset to any noticeable extent. The dogged tendency of an alluvial stream to throw up crossing bars, and thus pool the flow, is still present in the improved river. All changes in basic river regimen are under critical observation, with a view toward taking any action that may be indicated should adverse tendencies develop.

RESULTS SO FAR ACCOMPLISHED

I wish, in closing, to call attention to the results that have so far been accomplished in improving the channel of the Missouri River for navigation. At the present time, approximately 95% of the total river mileage from Blair, Nebr., to the mouth has a channel with a minimum depth of 6 ft, and a minimum width of 200 ft, at river discharges comparable to the minimum that will be maintained under full Fort Peck Reservoir regulation. Further, approximately 85% of the total river mileage in this same section had a channel with a minimum depth of 9 ft and a minimum width of 300 ft when Fort Peck stages prevailed.

In response to a Congressional resolution predicated on the channel development so far accomplished, the Chief of Engineers has recently submitted a favorable report on a 9-ft project between Sioux City and the mouth. This report is embodied in House Document No. 214, 76th Congress, 1st session.

Silica Dust Control at Hiwassee Dam

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DUST FROM DRY ROCK ON PRIMARY STOCK PILE

HIWASSEE Dam, completed recently by the Tennessee Valley Authority, is located on the Hiwassee River in western North Carolina. For this straight gravity-type concrete structure, about 310 ft high and 1,500 ft long, approximately 1,700,000 tons of crushed stone aggregate (both coarse and fine) were produced on the job. (See "Production Methods at Hiwassee Dam Aggregate Plant," by F. Cadena, *Mining Technology*, January 1939.) Dust control in the quarry and aggregate plant was an interesting feature of the project and certain observations on the effectiveness of the control measures, recorded in this paper, may prove useful elsewhere.

The Hiwassee rock, known as graywacke, is a micaceous partially metamorphosed sandstone, containing 60 to 80% quartz (free silica). During the planning of the dam it was realized that the extensive quarrying and processing of this rock would introduce a potential silicosis hazard unless adequate dust control measures were adopted. Accordingly, the principal control measures were provided for in the original plan of operation and in the design of the aggregate plant.

Silicosis is a disease of the lungs caused by the prolonged inhalation of dusts containing free silica (SiO_2). Since the finer particles (below 5 microns in size) are considered especially harmful, evaluation of silica-dust hazards is generally based upon a measure of the number of particles present in a known volume of the atmosphere. In accordance with standards of the U.S. Public Health Service, it was decided that average dust exposures in excess of 5 to 10 m.p.p.c.f. (million particles per cu ft of air) should be considered unsafe. Inasmuch as average dust concentrations resulting from stone crushing operations commonly exceed 200 m.p.p.c.f., somewhat rigid control measures were necessary. All dust studies were made in accordance with U.S. Public Health Service technique, using the Greenburg-Smith impinger and light field low-power magnification, with results expressed as the number of countable particles collected from 1 cu ft of air when observed under a magnification of 100 times.

The flow diagram of the aggregate plant is given in Fig. 1.

In the quarry no measurable concentrations of dust resulted from the operation of the churn drills used in all primary drilling. However, an unusually large amount of secondary drilling with hand-operated pneumatic drills (jack-hammers) was carried on as a full-time quarry operation, and preliminary studies had shown that dry drilling with jack-hammers produced dust in concentrations of above 150 m.p.p.c.f.

Consideration was given, at first, to two well-known methods of dust control at the jack-hammers: (1) exhaust ventilation at the top of the drill hole, with dry drilling; and (2) the application of water under pressure at the bottom of the hole, with wet drilling. On the basis of early test results, wet drilling was judged to be the more practicable method, especially since operations were to be carried on in the open. Air samples collected in areas where wet drilling was in progress indicated maximum dust concentrations ranging up to 7 m.p.p.c.f., with an average concentration of 4 m.p.p.c.f. Thus wet drilling proved to be highly satisfactory.

After full-scale quarry operations were begun, the additional dust-control problems in this area were largely those associated with operation of the 3-cu yd shovels, when working in dry rock, and of the five 12-cu yd trucks used to transport the rock to the primary crusher. At times average dust concentrations in the cabs of power shovels were found to be as high as 70 m.p.p.c.f. Dust from these sources was controlled by continuous wetting of rock piles in areas ahead of the shovels and by systematic sprinkling of the quarry floor during dry weather.

LARGE ROCK CREATES DUST PROBLEM

Power shoveling, however, continued to be one of the most consistently dusty operations in the stone plant. When handling large rock, considerable amounts of dust were created by impact and attrition even when the material was wet. Moreover, with high pile-up of dry blasted rock, frequent slides were especially troublesome. Except during protracted dry periods, however, measured dust concentrations in the vicinity of power shovels were found to be generally below 10 m.p.p.c.f. (average, 6 m.p.p.c.f.).

Primary crushing was done in a gyratory crusher having a 42-in. feed opening and a $4^3/_4$-in. discharge opening, and discharging at a rate of about 500 tons per net hour. A water spray was directed onto the rock as it was dumped from the trucks, but this was not always effective to the desired degree since at times the water did not become fully dispersed over the rock surfaces. With large clean rock from the quarry, dust concentrations at the top of the crusher frequently exceeded the 5 to 10 m.p.p.c.f., but only a few samples gave counts higher than 20 m.p.p.c.f. (average, 13 m.p.p.c.f.). (All samples were collected down wind from the crusher and during actual operation only.) Measured dust concentrations in the operator's control room while crushing ranged between 1 and 6 m.p.p.c.f. and indicated a full-time average exposure of the operators of less than the 5 to 10 m.p.p.c.f.

SILICOSIS is a dread specter that haunts the construction man. On the Hiwassee Dam, two methods for keeping down silica dust were used—spraying with water to the amount of 9 gal per ton of rock, which was found to be the most generally effective means; and exhausting the dust-laden air at strategic points. These precautions not only were eminently successful from the standpoint of health but also paid dividends in safety, efficiency, and mechanical maintenance.

It was realized at the outset that, even though water was to be added at the crusher feed opening, considerable amounts of dust would be liberated at the crusher discharge as a result of the formation of new dry rock surfaces. Hence mechanical exhaust ventilation equipment was installed here as the principal means of control. The exhaust hood formed an enclosure over the entire discharge chute, and an air flow of some 5,000 cu ft per min (4,000 cu ft per min as a minimum) was drawn from the hood through two 12-in. ducts. The control of dust at the crusher discharge proved to be satisfactory, and dust counts near the hood averaged 9 m.p.p.c.f. Subsequent tests indicated a dust production of about 2,300 lb per net hour with dry rock fed to the crusher, as compared with 2,100 lb while using wet rock. Thus water had little effect on the amount of dust produced in crushing.

Dust-laden air drawn from the hood was circulated in a commercial wet-type centrifugal collector and discharged through a 60-ft stack. The stack was installed, however, only after early tests had shown dust concentrations in the collector effluent to be 500 to 1,500 m.p.p.c.f., which was several times higher than the expected maximum concentration. Frequent observations and tests indicated that the dust from the stack did not return to working areas to any measurable degree. The collector did not prove to be highly effective in the removal of fine dust particles (below 2 to 5 microns), but it did embody the desirable features of simplicity and low cost of operation, and continuous automatic disposal of collected dust.

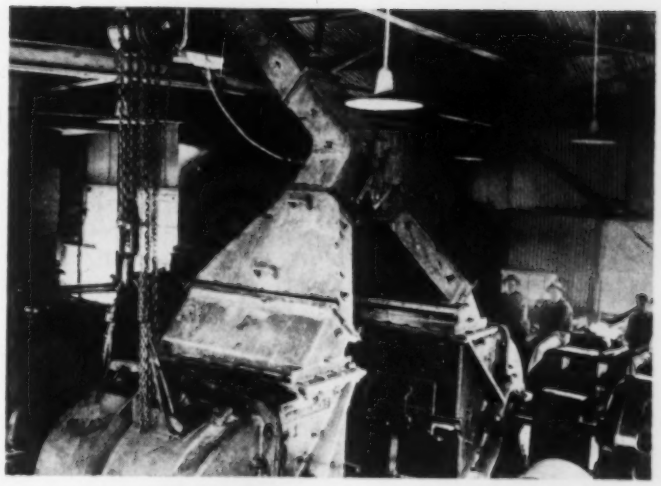
PRECAUTIONS FOR AIR AND WATER CONTROL

Air velocities of about 3,500 ft per min were maintained in the duct system, and with a normal dust removal of roughly 2,000 lb per net hour (maximum particle size, 400 microns), there was no tendency for dust to accumulate in the lines. In fact, it was found that the air velocities could be reduced below 2,000 ft per min before any deposition of dust occurred.

Since much of the primary-crusher product was dry as a result of the new surfaces formed, a water spray was applied to the material on Conveyor A (Fig. 1) leading to the primary stock pile. The water effected partial control of dust at the stock pile, which was isolated from working areas, and aided in the control at subsequent points. The amount of water was necessarily limited, however, to avoid interference with the flow of the fine material through screens and chutes, and also because an excess of water might cause slippage of the conveyor belt.

In the reclaiming tunnel under the primary stock pile, the rock was fed onto a 36-in. belt conveyor. A continual current of fresh air, at a velocity of some 200 ft per min, was drawn through the tunnel, but because of the dampness of the rock, dust production in the tunnel was normally low and dust counts of samples collected at the feed end did not exceed 3 m.p.p.c.f.

The crusher building (Fig. 2) was a closed steel structure, 60 by 40 by 70 ft high, in which rock from the primary stock pile was screened into seven sizes, as a scalping operation, and then selectively crushed to give the desired combined grading. Scalping was done in a series of three double-deck, open, vibrating-type screens located on the second and third floors; the screen openings ranged from $7^1/_4$ in. down to $^1/_4$ in. Crushing was done in a $5^1/_2$-ft cone crusher (secondary crusher) and in four 42-in. hammermills. The rock passed through the crusher building by gravity in a system of closed chutes and stone ladders; the finished products were recombined on a belt conveyor in the basement and transported to the aggregate sizing screens.



INTERIOR OF CRUSHER BUILDING, WITH HAMMERMILLS

Although the rock as delivered to the crusher building was somewhat damp (moisture content of $^1/_4$-in. fraction, 0.6% of dry weight of total feed), mechanical exhaust ventilation was required at several points in the building. The vibrating screens were enclosed in two interconnected rooms which together formed a dust chamber some 8,000 cu ft in volume, with walls of wooden frame and matched board construction. Ample clearance was provided around the screens for maintenance operations. Air was drawn from the room through a 22-in. duct at a rate of about 9,000 cu ft per min, and dust counts of samples collected just outside averaged 4 m.p.p.c.f. Although test results indicated that the air flow could have been reduced below 6,000 cu ft per min with no significant increase in dustiness outside the room, the additional air flow was maintained to reduce the dust concentration inside the room to a tolerable level (50 to 100 m.p.p.c.f.) at which intermittent servicing of the screens could be carried on with reasonable safety and comfort during operation. Although screening with damp rock greatly reduced the atmospheric dust, appreciable amounts settled on floors, beams, and other areas. The total area of all measurable openings into the room was reduced to a minimum (roughly 50 sq ft); the average inward airflow velocity, therefore, was 180 ft per min.

The secondary crusher, with an average output of 250 tons per hour (minus $1^1/_2$-in. product), discharged onto Conveyor C (24-in. belt) located in the basement. Thence the rock was transferred back to Conveyor B (Fig. 1) and to the crusher building for reprocessing, water being added at the transfer point. Exhaust ventilation was applied at the secondary crusher discharge with an air flow of 2,800 cu ft per min through the hood and 12-in. duct. This rate was found to be inadequate to prevent the occasional escape of dust from the hood with surges of rock through the crusher, although measured dust concentrations near the hood usually did not exceed 15 to 20 m.p.p.c.f. The normal dust loading in the air

BATTERY OF CONVEYORS FOR SIZING SCREENS

stream was found to be about 1,200 lb per hr, with a maximum particle size of 300 microns. Here again, test results showed that the air velocity in the duct (normally 3,600 ft per min) could be reduced below 2,000 ft per min before deposition of dust occurred in the duct. At the top of the crusher there was little tendency for dust to excape from the unenclosed space around the feed opening, possibly because of downward air currents induced by the flow of rock and the slight negative pressure in the exhaust hood below. Dust counts of samples collected on the first floor in the vicinity of the secondary crusher ranged between 3 and 10 m.p.p.c.f.

REGULATING DUST FROM HAMMERMILLS

Two of the four hammermills were operated at a time, with a combined output of 225 tons per hour of fine aggregate, 30% of which was minus 100 mesh. The four discharge chutes from the hammermills and stone ladders (Fig. 1) were enclosed in a continuous exhaust hood extending 40 ft along the conveyor line, and an air flow of 8,000 cu ft per min was maintained through the hood and 17-in. duct. Because of the large amount of dust produced in the hammermills as a result of the great increase in rock surface, this operation probably required the major portion of the total air flow. Tests indicated that a total flow of less than 7,000 cu ft per min allowed the escape of significant amounts of dust from the hood. Dust counts on the first floor varied between 3 and 10 m.p.p.c.f.; and in the basement the over-all average concentration was less than 10 m.p.p.c.f.

All chutes and stone ladders were constructed with dust-tight joints, and the exhaust hoods were carefully constructed and installed to reduce all openings to a minimum. These particular features are believed to have been of major importance in maintaining effective dust control in the crusher building.

The combined air flow from all hoods in the crusher building was circulated in a wet-type centrifugal dust collector, identical in design with the smaller unit at the primary crusher, and thence through a stack. Here again, the collector effluent was found to contain dust in concentrations ranging from 200 to 800 m.p.p.c.f., but periodic investigation disclosed no evidence that this fine dust reentered the crusher building.

A test run was made to determine roughly the effect of omitting the sprays at the primary crusher and at all points along the conveyor lines. During the test the rock was processed in its normal dry state, having a moisture content of 0.05% (determined as before). The results indicated that, with dry rock, additional air flow would have been needed together with some refinement of the dust-control equipment. Specifically, (1) the dust concentration inside the screen room was found to be about 1,000 m.p.p.c.f., an unsatisfactory condition for servicing the screens during operation because of the health hazard and because of the poor visibility; (2) outside the screen room the dust concentration increased only from about 6 to 10 m.p.p.c.f., but some dust could be seen escaping from joints in the wooden partitions, indicating that with continuous operation using dry rock, dust-tight partitions would have been necessary; (3) dust control at the secondary crusher was inadequate—samples collected on the first floor near the secondary crusher gave counts above 60 m.p.p.c.f. while basement samples showed concentrations near the crusher discharge of more than 200 m.p.p.c.f.; (4) dust conditions at the hammermills remained much the same although there was some evidence that additional air flow in the hood would have been necessary with continuous dry operation.

The recombined crusher-building products were transported on successive conveyors, D and E, to the screening structure where the rock was separated into five sizes. Since the screens were located on an open elevated structure, isolated from the rest of the job, and required only intermittent servicing, adequate dust control was accomplished by the limited application of water. Measured dust concentrations near the screens ranged from 4 to 30 m.p.p.c.f., averaging 10 m.p.p.c.f.

WETTING PROVES MOST VALUABLE METHOD

In all subsequent operations in the aggregate plant the rock was handled in a wet state and no further dust-control problems were encountered. The results of all dust-control operations are summarized in Table I.

Viewing the operations as a whole, the most generally effective dust-control measure at Hiwassee was the application of water to dry rock. On the average, a total of 9 gal of water was added to each ton of rock. Although no determinations were made to indicate the minimum quantities of water required for individual operations, the degree of control appeared to depend a good deal on the amount of fine material present, the fines retaining a relatively high moisture content and tending to form a damp coating over the larger particles. Moreover, it

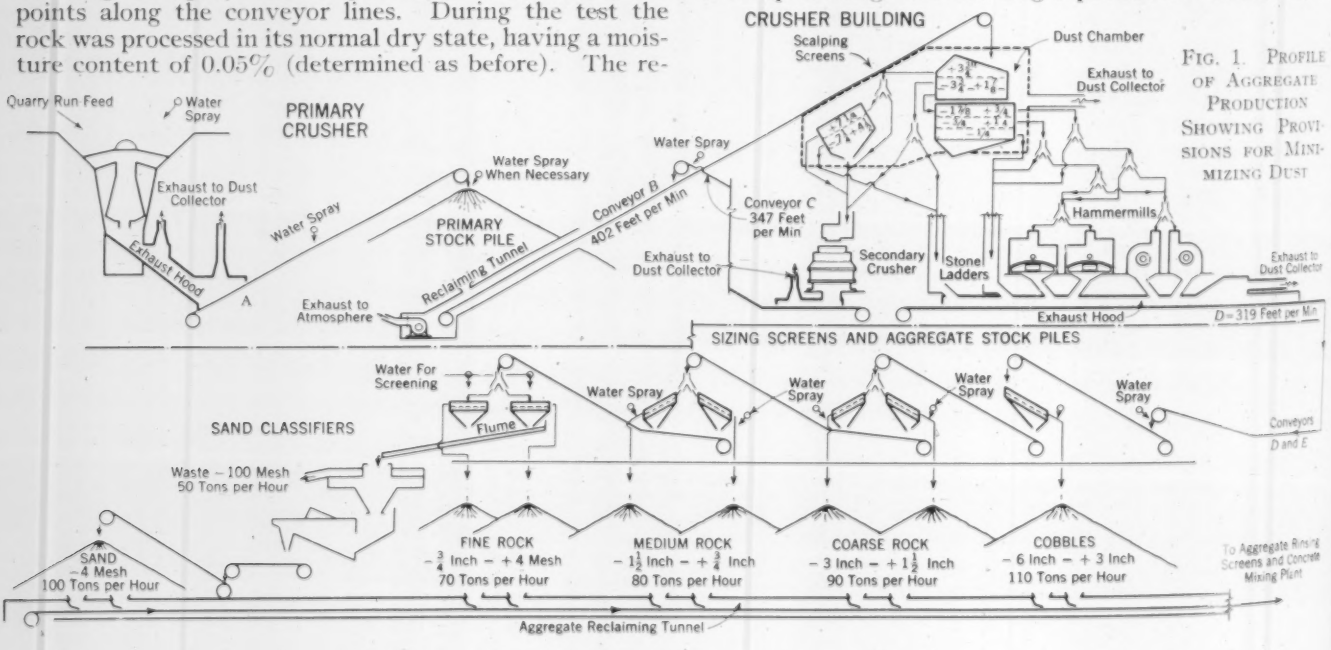

CRUSHER BUILDING
Scalping Screens
Dust Chamber
Exhaust to Dust Collector
Quarry Run Feed
Water Spray
PRIMARY CRUSHER
Water Spray When Necessary
Exhaust to Dust Collector
Water Spray
PRIMARY STOCK PILE
Conveyor B 402 Feet per Min
Water Spray
Conveyor C 347 Feet per Min
Hammermills
Exhaust Hood
Reclaiming Tunnel
Exhaust to Dust Collector
Secondary Crusher
Stone Ladders
Exhaust to Dust Collector
Exhaust to Atmosphere
A
Exhaust Hood
D = 319 Feet per Min
SIZING SCREENS AND AGGREGATE STOCK PILES
Water For Screening
Water Spray
Water Spray
Water Spray
Water Spray
SAND CLASSIFIERS
Flume
Conveyors D and E
Waste – 100 Mesh 50 Tons per Hour
SAND – 4 Mesh 100 Tons per Hour
FINE ROCK – ¾ Inch – + 4 Mesh 70 Tons per Hour
MEDIUM ROCK – 1½ Inch – + ¾ Inch 80 Tons per Hour
COARSE ROCK – 3 Inch – + 1½ Inch 90 Tons per Hour
COBBLES – 6 Inch – + 3 Inch 110 Tons per Hour
To Aggregate Rinsing Screens and Concrete Mixing Plant
Aggregate Reclaiming Tunnel

FIG. 1. PROFILE OF AGGREGATE PRODUCTION SHOWING PROVISIONS FOR MINIMIZING DUST

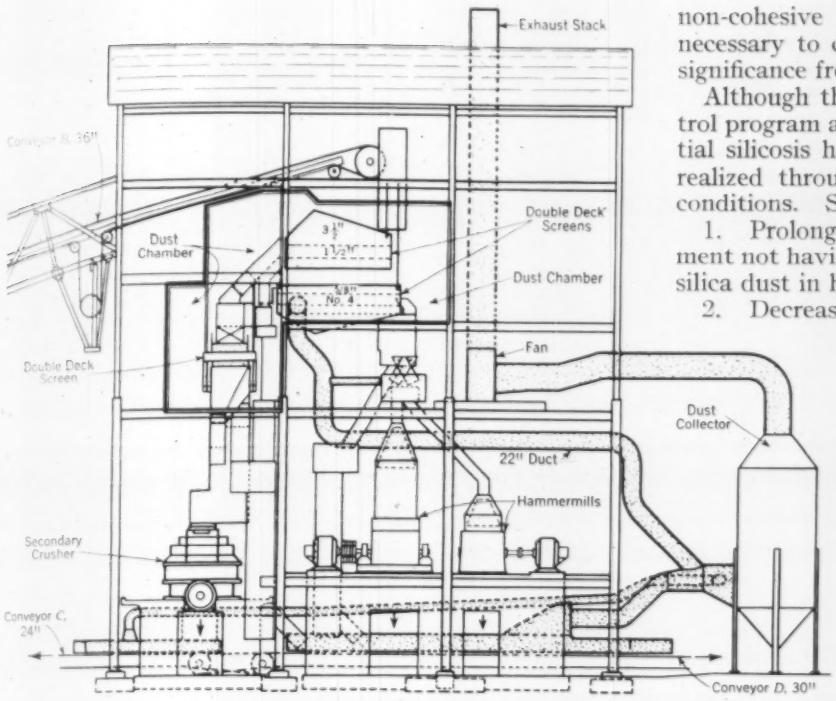


FIG. 2. CRUSHER BUILDING, SHOWING DUST COLLECTING SYSTEM

appeared essential that water be applied well ahead of control points in order that it might become thoroughly dispersed over the rock surfaces.

Although dust control by wet methods alone proved to be satisfactory for most of the operations carried on in the open, additional control through mechanical exhaust ventilation was required at the primary crusher and with all operations in the crusher building. In the design of the ventilating systems there appeared to be no sound basis for calculating the required air flows, especially in the case of exhaust hoods to be used at discharge or transfer points. It was found, however, that the flow must be sufficient to overcome opposing currents set up by surges of material through crushers and chutes, and by the motion of conveyors in addition to the normal inflow of air required through all openings.

Adequate dust conveying velocities in horizontal ducts were found to be as low as 2,000 ft per min, as compared with 3,500 to above 4,000 ft per min commonly recommended for similar plants. The Hiwassee results are not surprising, however, since only particles below 300 to 400 microns were being handled. In many cases, therefore, the power requirements in the operation of pneumatic dust-removal systems handling non-cohesive material may be excessive because it is necessary to convey large-size particles which have no significance from a hygienic or nuisance standpoint.

Although the real objective underlying the dust control program at Hiwassee was the elimination of a potential silicosis hazard, additional important benefits were realized through a marked improvement in operating conditions. Some of these were:

1. Prolonged useful life of machinery and other equipment not having been subjected to the abrasive action of silica dust in high concentrations.
2. Decreased probability of accidents.
3. Improved efficiency and morale of workmen not exposed to dusty atmospheres nor encumbered by personal protective devices.

The dust control program at Hiwassee Dam was carried on under the joint supervision of the Engineering and Construction and the Health and Safety departments of the Tennessee Valley Authority: C. E. Blee, M. Am. Soc. C.E., was project engineer; O. Laurgaard, M. Am. Soc. C.E., construction engineer; J. E. Walters, construction superintendent; Dr. E. L. Bishop, director, Health and Safety Department; and Dr. S. Fred Strain, chief, Occupational Hygiene Division. The authors wish to express their appreciation to these officials for their cooperation in preparing this paper. Particular mention is made of the work of F. Cadena, formerly associate materials engineer, who was closely associated with the design and installation of the dust control equipment.

TABLE I. SUMMARY OF DUST STUDIES AT HIWASSEE DAM AGGREGATE PLANT

Operation and Description of Sampling Point	Quantity of Material Handled	Dust Control Measures	Measured Dust Concentrations (m.p.p.c.f.)					
			Without Control			With Control		
			Av.	Max.	Remarks	Av.	Max.	Remarks
Quarry:								
1. Jack-hammer drilling	....	Wet drilling	187	309	...	5	24	...
2. Power shoveling	3 cu yd	Water application	...	70	...	11	26	...
3. General quarry area 50 to 100 ft from dusty operations	....	Water application	...	105	...	6	9	...
Primary Crusher:								
4. Over feed hopper	500 tons per hr	Water application	...	...	No data	16	25	Down wind
5. In operator's control room	....	Water application	...	...	No data	3	6	...
6. Vicinity of discharge chute	....	Water application plus exhaust ventilation at 5,000 cu ft per min	...	225	...	10	10	...
Crusher Building:								
7. Third and fourth floors outside screen room	500 tons per hr	Water application plus exhaust ventilation at 9,000 cu ft per min	8	10	Only water omitted	3	6	...
8. Third floor inside screen room	....	Same	1,000	...	Only water omitted	107	173	...
9. First floor, vicinity of secondary crusher	250 tons per hr	Water application plus exhaust ventilation at 2,800 cu ft per min	60	...	Only water omitted	5	17	...
10. First floor, vicinity of hammermills	225 tons per hr	Water application plus exhaust ventilation at 8,000 cu ft per min	...	...	No data	3	5	...
11. Basement, vicinity of secondary crusher hood	....	Same as No. 9	250 240	... ...	Only water omitted Only exhaust omitted	16 ...	30 ...	... ...
Screening Structure:								
12. Vicinity of cobbles screen (6-in.)	110 tons per hr	Water application	...	35	Water added at primary crusher only	12	28	...
13. Vicinity of coarse and medium rock screens	80 and 90 tons per hr	Water application	...	35	...	6	26	...

Modern Construction Methods on Earth Dams—Part II

Sardis and Wappapello Dams Exemplify New Developments in Hydraulic and Rolled-Fill Work

By O. N. Floyd, M. Am. Soc. C.E.
Consulting Engineer, Dallas, Tex.

Last month Mr. Floyd discussed a variety of developments in the excavating, transporting, and placing of materials in earth dams, drawing mainly from the Pickwick Landing work to illustrate his points. This month he concludes his review with two other important "case histories"—Sardis Dam, as an example of hydraulic-fill construction, and Wappapello Dam, a rolled-fill structure embodying an interesting departure from conventional practice.

In a previous article I have discussed at some length the progress made in recent years in the methods and equipment employed in earth dam construction, and have pointed out that it is largely as a result of this progress that today's earth dams are both better and cheaper than those of a decade ago. In pursuing this topic further, it will be profitable to review briefly the operations at two important new dams—Sardis and Wappapello—which illustrate a number of outstanding developments in hydraulic fill and rolled fill work, respectively.

Sardis Dam (on the Tallahatchie River in Mississippi, about 55 miles south of Memphis) was well suited for hydraulic fill construction, and the construction of the dam embankment largely fixed the schedule for the project. The dam is in an area having a mean annual rainfall of about 50 in. with no dependable dry season, which is a serious handicap to rolled fill work. The main dam across the valley is about 8,000 ft long and 100 ft high, with maximum height above the stream bed of 117 ft. The total length of the dam is about 14,500 ft, and the dam embankment contains about 16,800,000 cu yd, of which 13,870,000 cu yd are hydraulic fill.

The surface material across the main valley on which the dam rests is silt, loam, and silty clay loam. This extends to depths of 5 to 25 ft, with an average depth of about 10 ft. Underlying it is a sandy material which in turn is underlain by a series of alternate layers of clay and sand of variable thickness and horizontal extent. This formation is underlain by sand to an undetermined depth. By avoiding the clay lenses this was good material for a hydraulic fill; on the other hand, the normal ground-water level was only about 10 ft below the ground surface and very little material suitable for a rolled fill was available in the valley. Material for such rolled fill embankment as was required was obtained partly from borrow along the abutment ridges, but most of it came from spillway and outlet excavation.

The hydraulic fill was constructed with a comparatively narrow central core which was predominantly of silt. It was cohesionless and consolidated rapidly. The shell material is coarse and medium sand with almost no gravel. Some of the physical properties of the embankment material are shown below:

Depth of Sample Below Surface	Unit Wt Lb/Cu Ft	Dry Wt Lb/Cu Ft	Void Ratio	Void Ratio 100% Cons.	Specific Gravity
		Core Material			
10	114.5	82.5	1.04	0.91	2.69
20	116.0	85.5	0.96	0.88	2.69
30	117.5	87.5	0.91	0.86	2.69
40	118.5	89.0	0.89	0.85	2.69
50	119.5	90.0	0.86	0.84	2.69
		Shell Material			
Average	110.6	98.0	0.70		2.67

A cutterhead-type suction dredge, having two 24-in. pumps in series, was used. Each pump was driven by a 3,000-hp, speed-controlled motor built for 3-phase, 60-cycle, 13,200-v current delivered to the floating dredge through a submarine cable. The dredge could dig about 50 ft below the water surface, but since most of the core material was in the top 10 to 15 ft, it was often necessary to limit the depth of borrow in order to obtain the required percentage of core material.

From the dredge to the embankment the pipe line was 24 in. in diameter. The floating line was $\frac{1}{2}$ in. thick, and had ball joint connections, while the shore pipe was $\frac{1}{4}$ in. thick and had coned slip joint connections with two hooks welded on near each end for ties. On the dam, the pipe line was supported on trestles and encircled the section of fill under construction. Discharge onto the beaches was through trap or bleeder pipe. The working length of pipe line varied from about 4,000 ft to 10,500 ft and averaged about 7,300 ft. Optimum pipe line velocity for maximum rate of output of solids was from 19 to 20 ft per second, and this was about the average velocity maintained.

Surplus water was drawn from the core pool through two low-head, electrically driven screw pumps, each mounted on a small barge in the pool. The discharge from these pumps was carried through shore-type dredge pipe carried on trestles across the upstream beach and on the embankment material down the upstream slope of the dam to original ground.

The dredge operated on a 24-hour-day, 7-day-week schedule, and the net operating time for the entire job was 70% of the possible. About half of the 30% lost time was due to mechanical and pipe-line delays common

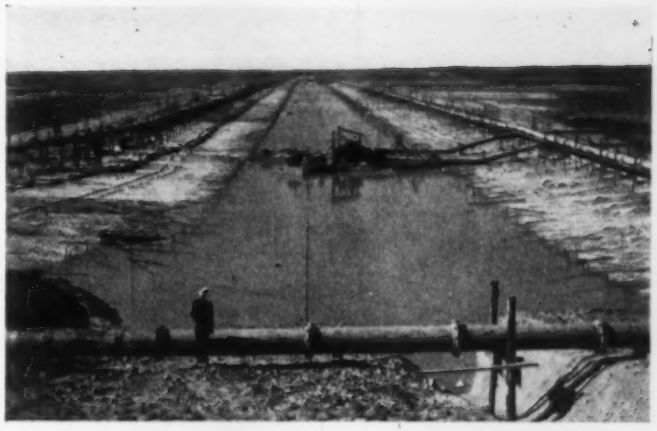
Looking Northeast Over Sardis Dam; Spillway Excavation in Foreground, Hydraulic Sections Under Construction

to all such work, and the rest was due to floods and various unexpected causes that may or may not happen on a job of this sort. Under favorable working conditions an output of 35,000 cu yd per day or about 1,800 cu yd per hour could be maintained for a few months at a time, and 45,000 cu yd per day could be obtained for a few days. The general average for the job was about 30,000 cu yd per day.

Generally, on each pump both the shell and the impeller remained in fair condition until about 750,000 cu yd had been delivered to the embankment. They were then built up to about the original surface by welding with specially hard metal at a cost of about $500 to $600 for each pump, and after this they would deliver about 750,000 to 1,000,000 cu yd more before being worn so that they had to be discarded. At the end of the job, when a total of about 14,000,000 cu yd had been pumped, the entire pipe line, including the ball joints on the floating line, appeared to be less than half worn out. The dredge hull is of timber and probably will never be moved, but all the framing and equipment, motors, and pump beds and parts are in excellent condition. This dredge was well designed and built for the work it had to do and was one of the few dredges used for hydraulic-fill dam construction that has had sufficient power on the main pumps to maintain the optimum velocity in the pipe line under practically all working conditions encountered.

The work at Sardis Dam was under the direction of the U.S. Engineer District Office at Vicksburg, Miss., and the construction of the hydraulic fill, including the building of the dredge, was done by hired labor. The cost of hydraulic fill, including all field engineering and overhead and plant depreciation, was $0.1855 per cu yd of embankment in place. It is estimated that additional depreciation for camp and high-tension power line to the project will amount to about 2 cents per cu yd.

The rolled fill for this dam was done by contract, and bid prices were so tied in with the required excavation included in the same contract, and the length of haul and other conditions were so different, that any comparison of these prices with the hydraulic fill costs would be misleading and of little value. However, there was nothing in the rolled fill prices or experience to indicate that the part of the dam done by hydraulic fill methods could have been done as a rolled fill without a material increase in cost.



CORE POOL AT SARDIS, SHOWING THE WASTE-WATER PUMPS AND THEIR DISCHARGE LINES

WAPPAPELLO DAM DESIGN

A departure from the conventional practice of building an earth dam with a central impervious core and pervious shells has resulted in a very material saving in the cost of the Wappapello Dam without in any way impairing the stability of the dam itself or of its foundation material. This dam is across the St. Francis River about 15 miles north of Poplar Bluff, Mo., and is under the direction of the U.S. Engineer District Office at Memphis, Tenn. It is a rolled fill and contains about 2 million cubic yards in the main dam embankment.

Early investigations of the spillway and outlet works sites and of the material in probable borrow areas revealed that there was ample impervious material, usually clay or sandy clay containing more or less gravel and small boulders, but that there was very little pervious material within economic hauling distance except in scattered deposits too small to be worked economically. It was apparent that to obtain pervious material for a dam of this volume, built to the usual cross section, would require some sort of plant to separate the clay and silt from the coarser sand and gravel. In this area of high annual rainfall and more or less permanently high moisture content of the natural ground, this separation could hardly be made without running the material through a regular screening and washing plant, which would have left the clay and fine sand too wet to use on the dam and thus would have added materially to the cost of the embankment.

The materials to be removed from the spillway and from the outlet works excavation were further explored by several large open test pits about 20 ft deep. Laboratory tests on these materials showed that they contained from 30 to 40% of shattered rock and disintegrated limestone from $\frac{1}{4}$ in. to 6 in. and probably 5% or more of boulders above 6 in. Laboratory and model tests also showed that, by discarding some pockets and scattered lenses of very high clay content and some pockets of sand, a homogeneous dam could be built with side slopes of 1 on $3\frac{1}{2}$ that would compact well, be quite impervious, and have sufficient stability, when saturated, thus avoiding the heavy expense for pervious shells. In order not to overstress the relatively poor material under a large part of the base of the dam, symmetrical upstream and downstream slopes were adopted as follows: beginning at the crown elevation of 420.0, 1 on $2\frac{1}{2}$ to elevation 405.0, thence 1 on 4 to elevation 378.75, thence 1 on 5 to elevation 376.0, and then 1 on 8 to toes of dam.

The specifications required that the material on the dam be spread in layers of such thickness that after rolling with the usual size and type of sheepsfoot roller, each layer would not be more than 6 in. thick. Before rolling, all cobbles or boulders more than 6 in. in diameter were removed from the top of the embankment. At least 8 passes of the roller were required.

Laboratory tests and the rolling of a small test embankment had indicated that when rolled as specified

SPILLWAY EXCAVATION AT WAPPAPELLO DAM

POCKET PIPE DISCHARGES OVER HYDRAULIC FILL AT SARDIS

within 2% of optimum water content, a dry weight compaction of about 110 lb per cu ft could be obtained. Construction started about the middle of October 1938, and for most of the time until the following summer the material for the rolled fill contained more than the optimum moisture as it came from the excavation. During this early period the compaction of the rolled material was quite variable, owing in part to wide variations in clay content but probably more to variable and excessive moisture. The average dry weight after compaction was about 97 lb per cu ft. (In determining compaction weights, all gravel retained on a No. 4 mesh sieve was screened out. The average gravel removed from the test samples was about 37%.) With the large amount of gravel in this fill and with the ample cross section that had been provided on account of the base material, the compaction to 97 lb per cu ft dry weight did not cause any particular concern, but better compaction was expected during the summer and fall while closer moisture control was possible.

EXPERIMENTS WITH ROLLERS OF VARIOUS TYPES

As the sheepsfoot roller tended to keep the larger gravel and cobbles in the top few inches loose, it was suggested that a different type or weight of roller might do a better job on this material. To determine this considerable experimenting was done with full-size rollers on test strips on the dam. The details of these rollers and the results cannot be given here, but besides the specification sheepsfoot roller of more or less standard weight and spacing and size of feet, a very large sheepsfoot roller was used having feet with the usual 7 in. of bearing face but loaded up from about 267 lb to 583 lb per sq in. of contact area. Also a smooth-surface concrete cylinder roller, 5.2 ft in diameter and 5.0 ft long, having a total weight of about 16,000 lb, was tried. Finally a steel box with nine pneumatic tires in two rows, so spaced that rear tires completely covered the space between the front tires, was built and loaded up to a total weight of 11,400 lb, or about 57 lb per sq in. of contact surface of the loaded tires. This latter roller was suggested by the excellent compaction obtained by a proper and systematic coverage of certain sections of the embankment by the heavily loaded hauling equipment.

Because of limited time, changing weather, and variations in excavated material it was impracticable to conduct all these rolling tests under identical conditions, but enough was learned to show the decided superiority of the two sheepsfoot rollers over the concrete roller and the pneumatic roller. The heavy sheepsfoot roller gave on the average somewhat better results than the specification sheepsfoot roller. However, the optimum moisture was from 3 to 5% lower for the heavy roller than for the standard, which was a disadvantage for material that was often too wet. It was plain that the possibly slight advantage of the heavy roller would not justify the increased cost of purchasing and operating such rollers.

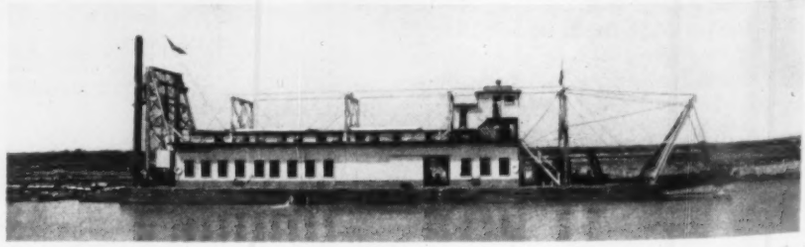
From May 1939 to the present time, a schedule adjusted to better weather and ground moisture conditions has permitted a much better control of the moisture in the material at the time of rolling, and the average dry weight per cubic foot compaction with the specification sheepsfoot roller averaged about 108 lb. Two sets of rollers in tandem pulled by a crawler-tred tractor are used for the rolling.

The work at the Wappapello Dam is being done by contract. The bid price for common excavation, which furnishes the material for most of the rolled fill, is 23 cents per cu yd, and the bid price for spreading and compacting the principal item of rolled fill is 5 cents per cu yd. The computed average haul for all earth moving was 2,600 ft. To July 1940 the average actual haul for material used in the dam has slightly exceeded the estimated haul, but there has been a greater volume of unsuitable waste material (26.4%) than expected and the haul on this has been shorter than estimated, so that the over-all average is close to the early estimate.

For loading and hauling this material the contractor began with two 2-yd shovels, ten 8-yd wheeled-tractor-and-truck units, and five 8-yd trucks. On May 20, 1940, a $2^1/_4$-yd shovel and six 8- to 10-yd wheeled-tractor-and-truck units were added to handle some change orders and to be ready for the river closure. The average loading time for one of these units is $1^1/_2$ minutes for four buckets. For best results the number of hauling units required for each shovel for various lengths of haul has been found to be about as follows:

LENGTH OF HAUL	NO. OF WHEELED-TRACTOR-AND-TRUCK UNITS	NO. OF LOADS EACH PER HOUR	TOTAL LOADS PER HOUR
1,000 Ft	5	9	45
1,500 Ft	6	7	42
2,400 Ft	7	6	42
3,000 Ft	7	5 +	40 +

Because of greater average road speed and quicker dumping, a tractor-truck unit usually handles about 20% more yardage per shift than a truck. Each loose load of 8 cu yd has produced 6.4 cu yd of compacted fill after discarding about 5% of oversize rock from the material spread on the dam. Most of this discarded rock is used



U.S. DREDGE *Pontotoc*, A 24-IN. ELECTRIC CUTTERHEAD DREDGE USED IN THE CONSTRUCTION OF SARDIS DAM

The Hull Was Built by Government Plant and Hired Labor; Machinery Was Shipped In and Installed at Dam Site

for riprap on the slopes of the dam, which is paid for as a separate item.

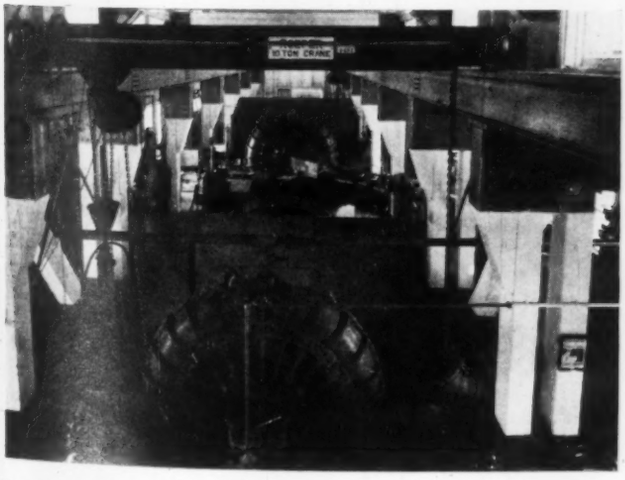
The space limitations of this article do not permit detailed descriptions of the excavation and hauling of the material for rolled fill dams by the modern power-scoop or carrying scrapers usually pulled by a heavy crawler-tread tractor. Very satisfactory results and costs have been obtained with units of this type where the hauling distance is generally not over about 1,000 to 1,200 ft. They have the advantage of one-man operation and of being able to excavate the material and load themselves quickly and cheaply. Moreover, they can usually dump and spread the material on the embankment in layers ready for rolling, while traveling. On the other hand, most of them are too slow for long hauls.

OPPORTUNITIES FOR IMPROVEMENTS IN EQUIPMENT AND METHODS

Apparently one of the greatest opportunities for improvement in dirt moving at the present time is to work out a machine or combination of equipment that can be loaded quickly and cheaply and maintain high average speeds between borrow pits and embankment and also be able to dump without stopping or slowing down too much. Already a good start has been made by some of the manufacturers on developing this new type of equipment with the self-loading advantages of the early power scoops and high-speed-travel advantages of the truck or wheeled-tractor-and-truck unit.

As for rolling and placing, much has been accomplished by a better knowledge of the effect of moisture variations and by better laboratory and field control methods, and for most materials the sheepsfoot roller has proved superior to most of the older types of rollers. Some limited examples seem to indicate that for certain materials better results may be obtained by increasing the area of each foot on the roller and loading the roller so that the load per square inch of foot contact is as great as or greater than the 250 lb per sq in. usually specified. There is need for more experimental work along this line, and some of the new rollers with removable feet should prove quite helpful.

Although the heavy concrete roller at the Wappapello Dam did not give as good compaction as either the standard or heavy sheepsfoot roller, that has not been true at some other places where gravel and even sandy shale were being rolled. There still appears to be a field for the heavy smooth roller, probably used in combination with the sheepsfoot.



INTERIOR VIEW OF DREDGE *Pontotoc*, SHOWING PRIMARY PUMP IN FOREGROUND AND BOOSTER PUMP BEYOND

Generally six to eight passes of a roller of suitable type, over material probably spread in layers from 6 to 8 in. thick and not too wet or too dry, will give the necessary compaction for safety and best economy—provided so many sets of rollers are not pulled by one tractor that the very helpful coverage of the tractor is reduced. The thickness of layer before rolling, and the optimum and permissible limits of moisture for a given material, can be determined approximately in the laboratory and finally established under field conditions. If the material in place in the borrow pit or excavation contains less moisture than the optimum for compaction it is usually easy and inexpensive to add water, but if, as is often the case, the material contains more than the optimum moisture when it reaches the embankment, it is not so easy to reduce this moisture very much without considerable delay and expense. Fortunately the presence of a small percentage of excess moisture in most materials will not reduce the compaction sufficiently to encroach materially on the usual liberal factors of safety provided in a rolled fill embankment. Little of value appears to be gained by trying, as is sometimes done, to pack the very last pound into the embankment by extra trips of the roller or by a too rigid control of the moisture.

SPREADING FILL AT WAPPAPELLO DAM; VIEW ALONG CENTER LINE FROM SOUTH ABUTMENT

The writer had many years of experience in building earth dams before anything of practical value was known of modern methods of soil mechanics, and his experience with soil technicians in years past has often reminded him of the impressions of the seven blind men who were led out to feel an elephant. At times there was consolation in the knowledge that some of the new theories could hardly be retroactive. However, at this time he would like to pay a grateful tribute to the few of the older soil technicians who have kept their feet on the ground and their minds open, and to the larger number of able younger ones who are following in their footsteps. If given an opportunity early enough these specialists can materially narrow the field of uncertainty in earth dam building and, at the same time, improve the quality and economy of the work. Fortunately they have come on the scene about the time when most of the good sites have been utilized, and their help is needed as never before.

ACKNOWLEDGMENTS

The writer wishes to acknowledge gratefully his indebtedness to Col. Raymond G. Moses, U.S. District Engineer, Vicksburg District, and Col. Daniel Noce, U.S. District Engineer, Memphis District, who have generously furnished reports, photographs, and other information from which many of the data for this paper are taken.

Fighting Property Depreciation in Downtown Pittsburgh

By WILLIAM S. WALKER

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MANAGER, TRANSPORTATION AND GOLDEN TRIANGLE DIVISIONS, CHAMBER OF COMMERCE, PITTSBURGH, PA.

OF tremendous importance in almost every large city today is the problem of property depreciation in the downtown district. How one city's chamber of commerce has organized to "do something about it," scientifically and energetically, is told here by Mr. Walker. It is particularly interesting to note how many divisions of the work involve the cooperation of the civil engineer, and how rapidly a "promotional" program is developing into an "engineering" program.

DURING the period from 1900 to 1929 the metropolitan centers of the United States experienced a phenomenal growth in business activity which resulted in a skyrocketing of real estate values. Then, with the collapse of the market in 1929, real estate values followed the general decline, this wholesale property depreciation being particularly in evidence in downtown business districts. Yet taxes either remained the same, decreased but slightly, or rose considerably.

This situation naturally so burdened business that some method of relief was essential, and this relief was found in a decentralization of industry and business in the downtown section and a gradual spreading out into outlying areas where taxes and rents were low. This movement, besides leaving many buildings vacant in the downtown district and resulting in further reductions in rental values, had other far-reaching and fundamental effects.

With the movement of industry and business to outlying areas came changes in transportation centers, location of industrial supplies, and the buying habits of the people. Communities began to develop in these new industrial areas and new commercial organizations constantly drained away business from the old metropolitan centers. Thus an already intolerable situation became worse. Business organizations having large investments in real estate and equipment could not afford to abandon them and start anew in outlying areas. As a consequence a definite movement began to take form to prevent further movement of business away from urban centers and to encourage the gradual return of some that had been lost.

In Pittsburgh these same decentralizing forces were at work and it was to combat them that the Golden Triangle Division of the Pittsburgh Chamber of Commerce was organized in October 1939. Its aim is to crystallize citizen effort behind a movement to stop depreciation of real estate values within the main business section (the "Golden Triangle") by making it a better place in which to work and transact business. In setting up committees in the Division an attempt was made to analyze carefully all the factors that would contribute in any way to this objective. The result was the formation of the following seven committees composed of prominent business men: Mass Transportation, Traffic Control, Long-Range Physical Planning, Home Rule, Tax Structure, Air Pollution, and Beautification.

PITTSBURGH'S "GOLDEN TRIANGLE," ONE OF THE MOST COMPACT BUSINESS DISTRICTS IN THE WORLD
In the Half-Square-Mile Area That Includes the Skyscrapers and "the Point" Is Concentrated 26% of the Assessed Valuation of the Entire City

Before describing the activities of these committees it will be well to present some informative data about Pittsburgh and its environs. Pittsburgh has an area of about 54.5 sq miles and a population of approximately 737,000. Within a 100-mile trading area the population is 6,000,000. The city itself has an assessed valuation of $1,070,000,000, of which 26% is concentrated in the downtown business district in an area of about half a square mile. Allegheny County, in which Pittsburgh is located, has 1,906 manufacturing plants with an annual output valued at $1,541,863,800, and is served by five railroads and three navigable rivers.

In 1927 a total of 593,750 people entered or left Pittsburgh's downtown section daily, whereas in 1937 this figure had dropped to 543,733. This decrease of approximately 50,000 occurred in spite of the fact that the business index rose 2% during the period. While the number of people decreased approximately 10% the number of vehicles increased 60%, as fewer people were brought in by trolley and railroad and more by buses and automobiles. Of all the traffic entering the downtown district, only 10% is through.

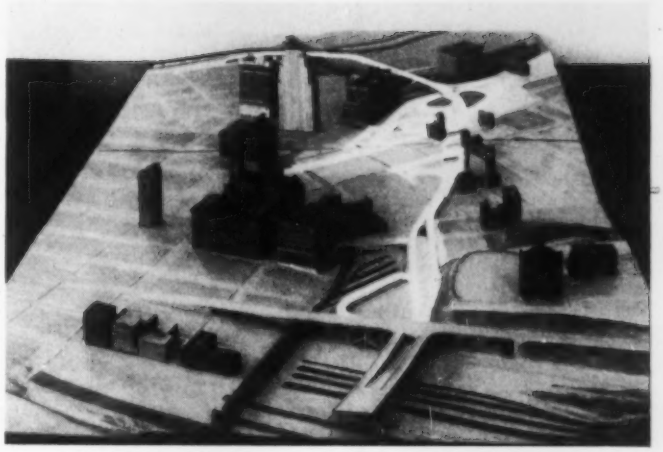
Now students of the decentralization problem agree that outside of retailers of convenience goods there is no general movement toward decentralization dictated by broad economic changes. Rather, decentralization comes because of disregard, by leaders in a centralized business area, of those factors which make for business in the district. Decentralization is in large measure man-made rather than a result of natural economic changes.

It is obvious that property values are influenced by transportation; transportation gives place utility; and people must be moved to the place of utility. Moreover, although people will travel where it is necessary to go, yet they will travel along the lines of least resistance. It is apparent that resistance in the form of traffic congestion will cause people who would ordinarily do business downtown to do it elsewhere.

The Mass Transportation Committee was organized to study ways and means of transporting people to and from the downtown district more efficiently. Recently this committee published a 125-page report comparing the mass transportation facilities of Pittsburgh with 17 other large American cities. Not only does this report point out the strong and weak points of our transportation system as compared with other cities, but it shows in bold relief the centers of congestion and the reasons for it. The influence of such factors as one-way streets, number of intersections, degree of officer control, curb parking, and street-car looping on fluidity of traffic movement and congestion are definitely established. How improvements in traffic fluidity can be effected without constructing any new public works is definitely pointed out.

This committee is also about to make a comprehensive survey of modes and times of travel of people entering the central business district. For all people the survey will include type of transportation, such as street-car, train, bus, taxi, foot, and automobile. In the case of the automobile, it is to be noted whether it was parked on the street, in a lot, or in a garage. The point of origin is to be determined—from the person's address—and also the time he arrives at and leaves, or expects to leave, the downtown section. In the case of the customer, the amount of his purchases at a store is to be determined in order to evaluate business in terms of the various modes of transportation and to show the merchant the actual money value of the automobile parked at the curb. If the merchant can be convinced that the car parked at the curb means little business to him, and probably actually reduces his business because of increased traffic congestion, then he should favor the elimination of all curb parking in the downtown area.

The work of the Traffic Control Committee is necessarily interrelated and correlated with that of the Mass Transportation Committee. Specifically, however, the problem of the former is to study ways and means of expediting traffic movement through the central business district. This committee is now studying the problems of constructing more street-car loading zones, paving and cleaning parking lots, developing parking lots along the periphery of the central business district, and the advisability of installing more parking meters.



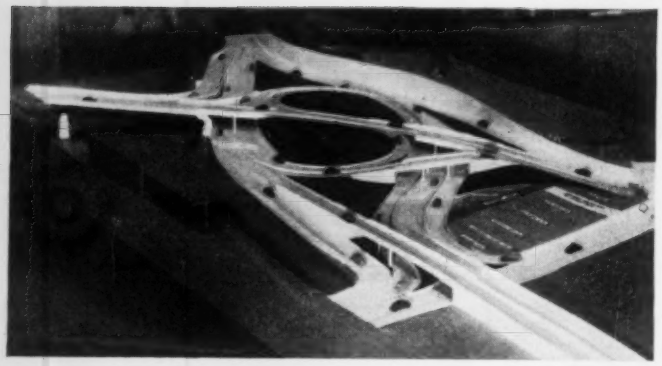
MODEL OF THE PROPOSED CROSSTOWN BOULEVARD
This Project Is Designed to Relieve One of the Most Serious Traffic Bottlenecks in the Golden Triangle

The Long-Range Physical Planning Committee studies proposed public improvements that are to be constructed over a period of years; and although this committee expends considerable effort on arterial highways, yet necessarily it is interested in and cooperates in solving the problems of the Mass Transportation and Traffic Control committees. At present it is advocating the rerouting of State Route No. 8 in the vicinity of Sharpsburg, Pa., and is progressing with the problem of adjudicating differences among the small boroughs regarding the route. This committee is also advocating the immediate construction of the by-pass for U.S. Routes 22 and 30, which will ultimately connect at its eastern terminus with the Pennsylvania Turnpike at Irwin, Pa., and thence proceed westward along the southern fringe of the Pittsburgh central business district. With the completion of the Turnpike, construction of this by-pass will be more than ever essential.

The progress of any major city is curtailed if too large a measure of control is vested in the state legislature. This is certainly the case in Pittsburgh, where with few exceptions an act of the state legislature is required to transfer a bureau from one department to another, to establish any new department, or to change in any way the existing employee pensions. The sources of tax revenue, the form of government, and the salaries of certain city officials are definitely limited and described by the legislature.

The Home Rule Committee is working on a plan to remove some of the control of the city from the state legislature and give Pittsburgh a larger measure of self-government. Both the County of Allegheny and the City of Pittsburgh have found it difficult indeed during the past decade to finance necessary public improvements with their limited sources of tax revenue and the inequitable returns from the state of motor vehicle taxes, license fees, and gasoline taxes.

The regrettable part of the motor tax program is that while huge sums are extracted by the state from the large city population, the city does not receive sufficient funds in return to provide necessary roadway and parking facilities within its limits. Huge sums are spent correcting old and creating new arteries leading to the city, while the city itself remains static to a great extent because of lack of funds to provide proper facilities to care for the increased traffic burden. In 1938 a total of $13,244,996 was collected in Allegheny County by the state and federal government as motor vehicle fees and gasoline taxes, yet the county received but $968,124, or about 7%.



ANOTHER VIEW OF THE PROPOSED CROSSTOWN BOULEVARD
Construction on the Seventh Avenue Bigelow Grade Separation (Foreground) Is Scheduled to Begin This Fall

As previously stated, many large cities have been faced with the problem of increased taxation in spite of the fact that real estate values have declined. Obviously this condition is created by a necessary increase in city expenditures for governmental purposes combined with delinquent taxes and insufficient sources of tax revenue. The Tax Structure Committee is cooperating with the city and county governments in an effort to reduce budgets as far as possible and at the same time collect all delinquent taxes. This program has been highly successful, and if more equitable tax returns from the state to the county, and more tax sources, are made available by home rule, then the tax problem will in a large measure be solved.

Many years ago Pittsburgh was dubbed "the Smoky City." At that time the steel mills belched out great volumes of smoke. However, in recent years the smoke created by industrial enterprises has been brought well under control, and it may be truthfully said that Pittsburgh is no longer the Smoky City. Nevertheless, smoke created by furnaces in the home is ever present, and prevailing winds carry smoke in from considerable distances beyond the city limits.

Through an educational program, the Air Pollution Committee is endeavoring to show the citizens the proper method of firing their furnaces so that the smoke nuisance will be decreased and at the same time fuel will be used more economically. A determined effort is also being made to extend the air pollution program throughout the county in order to eliminate smoke brought in by prevailing winds.

Unsightliness in a business district, besides reducing property values, constitutes a definite deterrent to people desiring to do business there. The Beautification Committee has effected the cleaning up of streets and is advocating removal of all overhanging signs, landscaping of boulevard escarpments, placing of bronze markers on historic sites, cleaning up of vacant store windows, and a program of street beautification by means of flower baskets suspended from light poles.

It is certain that Pittsburgh is only one of many metropolitan centers faced with the problem of property depreciation in the downtown district, and it is hoped that this article may suggest to others ways and means of solving this most important and pressing problem. During the short period in which the Golden Triangle Division of the Chamber of Commerce has been in operation in Pittsburgh, effective and worthwhile results have been accomplished.

The author wishes to thank Charles Cunningham, City of Pittsburgh Traffic Planner, and John F. Laboon, M. Am. Soc. C.E., director of the Allegheny County Department of Public Works, for supplying certain data and photographs for this article.

ENGINEERS' NOTEBOOK

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Model Tests of Large Sluice Gates at High Velocities of Approach and with Different Pier Noses

By JEFFREY B. MACPHAIL, ASSOC. M. AM. SOC. C.E.
and RAYMOND BOUCHER, ASSOC. M. AM. SOC. C.E.

RESPECTIVELY CIVIL ENGINEER, SHAWINIGAN ENGINEERING COMPANY LTD., MONTREAL, AND PROFESSOR OF HYDRAULICS, ECOLE POLYTECHNIQUE DE MONTREAL, CANADA

MOST of the published discharge coefficients for spillways and open sluice gates do not mention the effect of a variation in the height of sill—usually of course because only some particular site is under investigation. One is therefore apt to select a coefficient for a new case solely on the basis of resemblance of sill, and to forget the possible effect of differences in height. Even if this point is remembered, there is not much information available to show what adjustment is necessary. A case of this kind arose on a project on which one of the writers was engaged, and accordingly plans were furnished from which a model was built and tested by the other.

Tests were made in the hydraulic laboratory of the Ecole Polytechnique de Montreal, where there is a glass-sided flume 30 by 30 in. in section and 50 ft long. Water is measured by volume in calibrated tanks, and is re-circulated by a centrifugal pump through a constant-level reservoir. A flow of 3 cu ft per sec, or 1,350 U.S. gal per min is available.

The dam under consideration was to discharge with a maximum head of 31 ft, through openings of 50-ft clear width controlled by Stoney roller gates, dimensions which experience in this district has shown to be satisfactory. The piers were to rise 34 ft above the crest, and three different types of nose were under consideration, as

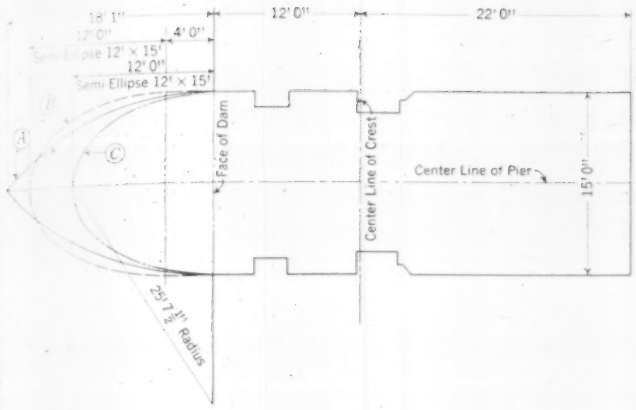


FIG. 1. PLAN OF TOP OF PIER, SHOWING THREE DIFFERENT NOSES

shown in Fig. 1. The one with the sharp point is of the proportions given by Creager and Justin in their *Hydro-Electric Handbook*, page 132. The sill downstream from the crest had the equation $Y = X^{2.2}/150$ to the point

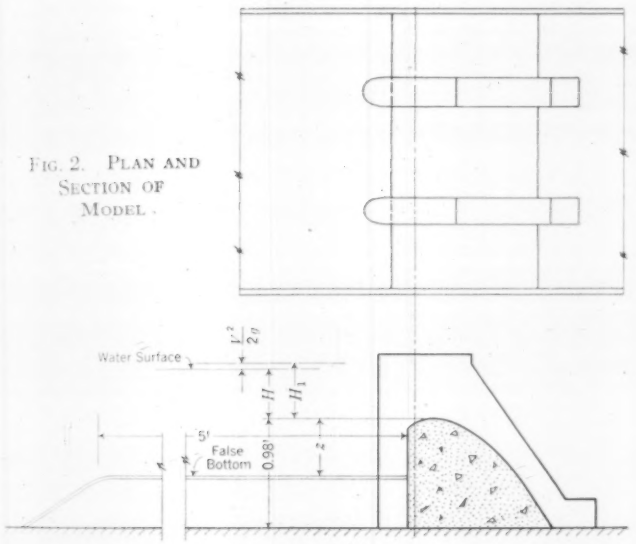


FIG. 2. PLAN AND SECTION OF MODEL

of tangency with an 8/12 slope; the upstream portion had a radius of 14 ft centered 0.5 ft upstream from the crest. Although the discharge coefficient for the sill

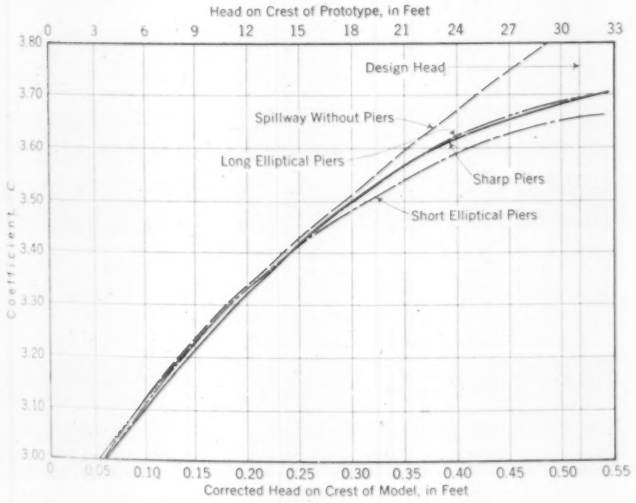


FIG. 3. COEFFICIENT-HEAD CURVES FOR PIERS OF DIFFERENT SHAPES

alone, without piers, reached the satisfactory value of $C = 3.83$ for the design head and maximum height, piezometer observations showed a zone of negative pressure downstream from the crest, and it was therefore decided that the prototype should be built with the Creager profile, which was known from tests by Escande and by Scimemi to be satisfactory. (See, for Escande, *Barrages*, Vol. 3, page 60, Hermann et Cie., Paris, 1937; and for *Scimemi*, TRANSACTIONS, Am. Soc. C.E., Vol. 103, 1938, page 1116.) To avoid vacuum at partial gate openings, the design head for shape should be more than the actual maximum head, again as mentioned by Escande (op. cit. page 66).

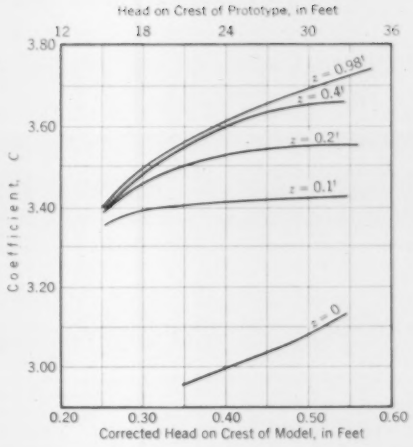


FIG. 4. COEFFICIENT-HEAD CURVES FOR VARIOUS MODEL HEIGHTS, *z*, OF SILL ABOVE FLOOR OF APPROACH CHANNEL

The model was built to a scale of 1:60 according to the arrangement shown in Fig. 2, giving one full opening of proper size and two side openings a little more than half the widths which they should be. This departure from the true scale had to be accepted, because correction of the condition would have required a larger model, with a flow that would have been beyond the capacity of the equipment. The sill was built of cement rubbed smooth with carborundum blocks and containing

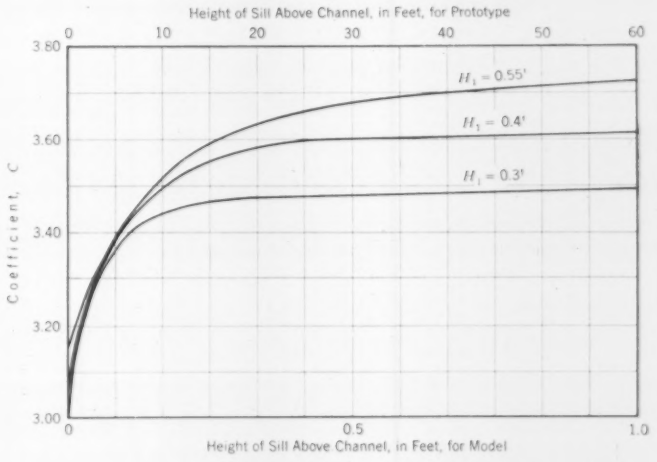

Height of Sill Above Channel, in Feet, for Prototype
$H_1 = 0.55'$
$H_1 = 0.4'$
$H_1 = 0.3'$
Coefficient, C
Height of Sill Above Channel, in Feet, for Model

FIG. 5. COEFFICIENT PLOTTED AGAINST HEIGHT OF SILL ABOVE FLOOR OF APPROACH CHANNEL FOR VARIOUS MODEL VALUES OF H_1

a brass strip in the center, drilled for 14 piezometer openings. The two piers were of painted wood, with three pairs of different noses. For construction reasons in the prototype, these noses were not cut off below the sill, but were continued right down to the base of the dam.

The results of the tests on the three different nose shapes are shown in the curves of Fig. 3, and they differ from one another by not more than 1%. Another curve shows results for the sill alone, with piers removed. All four were taken with the sill 58.8 ft high in the

prototype or 0.98 ft in the model, and the head was read 3 ft upstream. In all cases the velocity head $V^2/2g$, was added to the observed head on the sill, H, to give the corrected head, H_1. Using the ordinary formula, $Q = CLH_1^{3/2}$, the coefficient C was calculated and plotted against H_1.

A false bottom 5 ft long, of painted wood, was then inserted and placed at different depths below the sill, as in Fig. 2, to give various velocities of approach. The head was read 8 ft upstream from the model, but it was noticed that heads taken at the 3-ft point would have given essentially the same results, of course including corrections for the respective velocity heads. Only one set of pier noses, the long elliptical ones, was used.

The results of tests with the false bottom at different depths below the crest are shown in the curves of Fig. 4, with a cross-plot in Fig. 5. These tests show that the discharge coefficient for these gates at any given head remains nearly constant as long as the height of the sill is greater than the head, and that it diminishes rapidly as sill height becomes progressively less than head. They show also for small heads that the coefficient varies with the head, but at different rates for different heights of sill. These relationships may perhaps be of use to the hydraulic engineer in his task of guessing discharge coefficients from analogies with somewhat similar structures.

In applying this work to actual design, the usual doubts about possible departure from true similarity in flow arise. However, in the present case the true capacity of the prototype will not be of interest until there comes a flood much larger than anything yet observed in 40 years of record. The probable error in estimating the size of this flood is quite beyond possible errors due to departure from similarity, so no corrections for scale effect were made.

Skylight Improved by Adaptation of Piling Section

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ARCHITECTS, engineers, and owners alike have long felt the need for a dry sawtooth or monitor skylight such as is used on industrial buildings. There has generally been difficulty in building a skylight that will not drip as the result of condensation running down the inside of the glass and steel work.

The accompanying Fig. 1 (*a*) shows the typical detail for a continuous top-hung sash as generally used for industrial buildings and as shown in practically all the sash manufacturers' catalogues. Note that the top of the supporting angle slopes downwards on the inside, allowing all the condensation to run to the inside edge of the angle and drip. In a great many industrial installations this is very undesirable as the products manufactured may be injured by the dripping water, which is frequently none too clean.

Figure 1(*b*) shows the common use of flashing to divert the water to the outside. This is expensive and still does not prevent dripping due to condensation forming on the structural steel, which is considerable because the steel angle has been chilled by its exposure to the cold outside the building. This condition is noticeably aggravated by the presence of process steam in the air; also in buildings where the humidity is maintained at a high level by air conditioning, thus increasing the rate of condensation and drip.

Figure 1(*c*) shows a detail that has been used to some extent. The angles are turned on their axis so that water will run out, but the detail connections of the tophung sash at the head, the bearing at the sill, and the end flashings are rather awkward and troublesome.

Figure 1(*d*) shows a skylight detail using a 120-deg obtuse angle which improves the design considerably. The sash connects to the angle with the same ease as in the customary standard detail shown in Fig. 1 (*a*). Without the aid of expensive flashings, the water running down the inside of the glass will be diverted to the outside by the sloping leg of the angle. The troublesome condensation forming on the steel, which generally drips off the inside edge, will also follow the leg of the angle sloping to the outside, thus practically eliminating the all-too-often wet skylight.

This section is a $3\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{3}{8}$-in. 120-deg standard obtuse angle, generally used for the connection of sheet steel piling, and can be readily secured in the market. It was first used for skylights on a building for the Campbell Soup Company at Camden, N.J., in April 1935 by the Ballinger Company, architects and engineers.

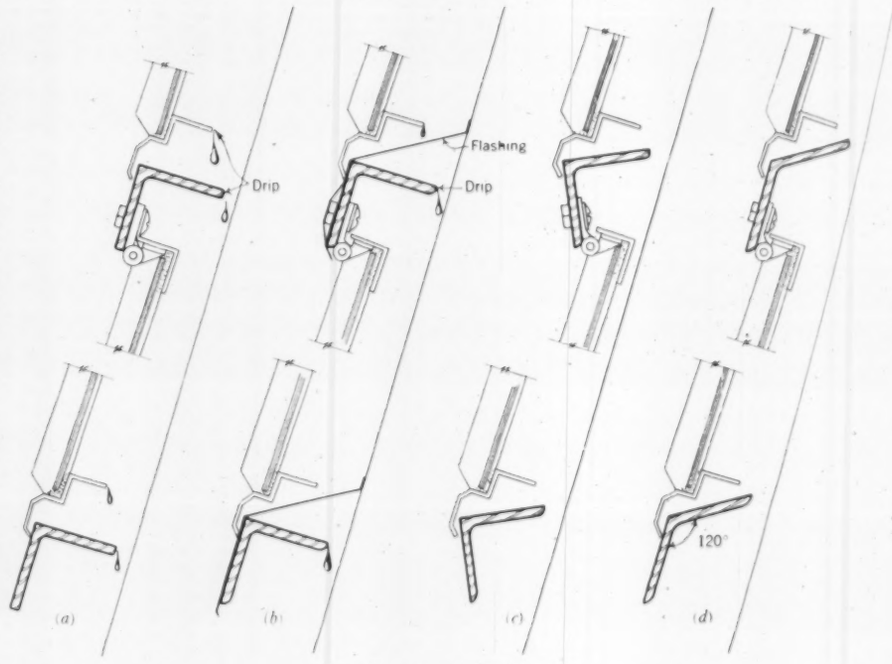

FIG. 1. SKYLIGHT DETAILS
(*a*) and (*b*), Common Details; (*c*), an Improved Arrangement; (*d*), the Author's Recommendation

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Present License Laws a Hindrance to the Young Engineer

To the Editor: In connection with Mr. Legare's article on "Legal Registration of Professional Engineers," in the May issue, it seems to me that a discussion of the underlying principles governing registration is in order.

Graduates are pouring out of our colleges again. Some will be placed; the major number will wonder where they can find employment. There is much work to be done, and youth can be usefully employed if we are intelligent enought to bring youth and work together.

In our democracies we have spent our energies setting up barriers of all sorts—tariffs to keep out trade, unions to keep workmen from their tasks! Professional societies have in recent years succeeded in having laws passed which make it increasingly difficult for young men to practice their professions even after graduating from accredited universities. There are associations clamoring for the licensing of building contractors, of chain stores, of all businesses. There are barriers set up by states to favor special products or interests. Labor in certain industries, such as the building industry, can only be hired locally despite membership in recognized unions. The barriers are many in form, but they are alike in being designed to freeze into permanence privileges possessed by those who are "in," to the exclusion of those who want the same privileges. The older men who built up these barriers did not, in their day, have to buck restrictive laws, union rules, license privileges.

A flagrant violator of youthful aspirations is our law affecting the licensing of architects and engineers. Under our state law a prospective architect or engineer may procure his license only after taking an examination four years or more after graduating from an accredited school. After graduation, in order to qualify for examination, the candidate must show evidence of having had at least four years of practical experience in professional work of a grade and character satisfactory to the examining board. It is clear that a man may be a fine student and yet never procure a license. He may or may not be able to get work. If he can find employment, he has no guarantee that his work will be judged satisfactory by an examining board. There is no definition in the law as to the nature of work that a board must accept.

The laws were sponsored by the professional societies which can easily influence legislators to pass restrictive measures because their lobbying is always coupled with a plea for public welfare. The individual prospective practitioner is inarticulate and unorganized. His side is never heard by the legislator. This is no plea to drop educational standards. Technical courses may be made as difficult as our complex civilization requires. But it is unfair to snare young men into studying for their degrees, and then to block them by law so they must work interminably for nominal wages or drop out of a profession for which they may be well fitted.

The laws of our state have been used as patterns for about forty other states. The viciousness of these laws will be felt only when we begin to need many good technicians. Our privileged practitioners who set themselves up before restrictions were so prevalent may profit temporarily through the reduction of competition. Society will pay for condoning these practices which are neither moral, ethical, nor economically sound.

The promoters of restrictive requirements set up the argument that educational standards must be sustained in order to keep the professions on a high level. Such argument is specious because a man may have the best education and yet be prevented by artificial means from practicing his profession. Labor unions, likewise a law unto themselves, are under no obligation to take in as members trained mechanics no matter how able. Many preeminent men would have been kept out of the fields in which they have won renown, if in their day there had been such restrictions as prevail now. Formal education in technics alone does not make a great practitioner. Witness the number of notable figures who made history in technics without the formal technical training and experience now legally prescribed.

There can be no cure for the evil condition existing today until the peers of the professions and labor unions assume the moral responsibility—even the negative one of leaving young men alone to find their own level—instead of bedeviling and belaboring them with man-made restrictions. Registration laws are in principle sound, but when coupled with conditions that it is impossible for young men to meet, the laws should be modified to conform to the needs of our society, to leave opportunity open, and to be compatible with simple honesty. Our laws and customs should not be used for continuing decaying hierarchies in labor and in the professions.

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Brooklyn, N.Y.

More on Skin Friction

To the Editor: In "Settlement Studies of Huey P. Long Bridge," in the March issue, Professor Kimball points out that all load on the piers is assumed to be transmitted to the soil at the bottom of the caisson seal, and adds: "The load that might be permanently transmitted through skin friction along the sides of the pier has never been determined." That statement is correct. However, lest it be construed that an important point was overlooked in design, some comments on the value of skin friction as a factor in the permanent support of bridge structures may be in order.

The designers of the foundations for the Huey P. Long Bridge (the writer's firm) have in their files a large amount of information concerning skin friction of caissons, the friction varying with the character of the surrounding soil, the depth of the caissons, and the shape and character of their surfaces.

The main caissons at New Orleans were sunk 170 ft below water level. The estimated weights available to induce sinking, in Caissons 1 and 2, ranged from 860 to 730 lb per sq ft of surface, and these weights could be increased by pumping down the interiors of the caissons, to 1,570 and 1,340 lb, respectively. Even with these estimated weights, some trouble was experienced in reaching the required depths, and serious run-ins occurred in two of the caissons before they reached their final levels. In these cases the caissons had hung up, partly by reason of skin friction, and excavation had extended below the cutting edges, permitting the inflow of sand at the bottom. When sinking to such great depths, the consideration of skin friction is necessary to the proper determination of the proportions of the caissons, which must be designed with sufficient weight to permit sinking without unreasonable difficulty.

It is not the practice of the writer's firm to consider skin friction as a permanent factor in the support of deep caissons for the following reasons: First, its value at a specific site is usually not known; second, the very act of sinking the caissons and the use of exterior lubricating jets and other devices to aid sinking, break down the skin friction and leave annular zones around the caissons of much disturbed material; and third, where run-ins occur at great depths, subsequent settlement and adjustment of the soil surrounding the caissons may actually create downward drag instead of providing the frictional support which might be anticipated from a purely academic consideration of the problem.

It is realized that a certain amount of support actually may be provided by the soil surrounding the caisson, and such support, if any, leads to discrepancies between theory and practice in soil mechanics. It is considered safer, however, in view of the methods usually followed in the sinking of caissons, and of the resulting uncertainty as to the value of the friction, to consider the bearing strata under the caissons as providing the entire support for the bridge.

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Computing Cross-Section Areas by Means of Coordinates

TO THE EDITOR: Articles dealing with some of the practical aspects of engineering practice which can be studied and used by junior engineers are always of great value. An example of such an article appeared in the March issue under the title "Reducing Cross-Section Notes on Highway Construction" by Clifford B. Potts. Computing the areas of earthwork cross sections by the coordinate method, which is demonstrated in this article, is probably as old as the science of land surveying. Anything to be said on the subject would be for the purpose of facilitating the computations. Such was the main purpose of Mr. Potts' paper, and I have the same object in mind.

The writer's experience in computing areas of cross sections was as a junior and later as a senior engineer in the construction of a considerable mileage of steam railways; as a consulting engineer in the construction of steam railways, highways, and streets; and as a member of the engineering board of the Interstate Commerce Commission, in charge of the valuation of railways. The latter work included the computing of the cross sections of the road beds to determine the quantity of excavation and embankment. These were taken at every 100 ft, and frequently at intermediate points. The mileage of railways at that time consisted of 256,540 miles of main line, 32,370 miles of first and second, and 30,059 miles of yard and side tracks. The number of cross sections taken and computed was something in excess of 15,000,000.

Very early in the writer's experience he found it extremely desirable to devise a method of computing the areas of cross sections by means of coordinates, whereby errors could be discovered and corrected without a complete re-computation. To accomplish this it was necessary that the original computations be preserved so that later they could be compared with the re-computations. After several months' study and observation the following method was developed:

Invert the cross section. Place the width of the road bed on each side of the center line over 00 at the end of the inverted cross section, as 10.0/00 or 20.0/00. Multiply the middle denominator, which is the elevation at the center-line, by the sum of the two adjacent numerators. Multiply each remaining denominator by the algebraic difference of the two adjacent numerators, subtracting the inner from the outer. One-half the algebraic sum of these computations equals the area of the cross section.

Applying the foregoing rule to the cross section which appeared in Mr. Potts' Fig. 1, we have

20.0	32.0	27.0	25.0	23.0	20.0	15.0	7.0	0.0	2.0	12.0
0.0	(4.0)	3.7	3.6	3.8	3.9	4.0	3.9	3.4	3.1	0.0
	(−7.0)	7.0	4.0	5.0	8.0	13.0	15.0	9.0	12.0	

−28.00 25.90 14.40 19.00 31.20 52.00 19.50 30.60 37.20
39.
58.50 30.60
58.50
52.00
31.20
19.00
14.40
25.90
268.80
28.00
2)240.80
120.40 sq ft excavation

12.0	14.0	20.0	26.0	30.0	35.0	20.0	
0.0	1.3	2.5	3.0	4.0	4.5	0.0	
	8.0	12.0	10.0	9.0	(−10.0)		

10.40 30.00 30.00 36.00 (−45.00)
30.00
30.00
36.00
106.40
45
2)61.40
30.70 sq ft embankment

This computation sheet is preserved for checking. At a later date when a computation for checking is made by the same rule, it will be observed that where the answers are found not to be the same, a comparison may be made whereby the error may be quickly detected and corrected without a complete re-computation.

When faced with the tremendous task of computing cross sections for all the railroads in the United States it is necessary to use computing machines. The same rule was followed by recording the first computations and conserving them for consequent checking. In this case the cross section was inverted as before and the numerator for each denominator determined. This provided a series of multiplications, additions, and subtractions, the algebraic sum of which was recorded on the computation sheet. The computation sheet in this case would appear as follows:

20.0	32.0	27.0	25.0	23.0	20.0	15.0	7.0	0.0	2.0	12.0
0.0	4.0	3.7	3.6	3.8	3.9	4.0	3.9	3.4	3.1	0.0
	(−7.0)	7.0	4.0	5.0	8.0	13.0	15.0	9.0	12.0	

2)240.80
120.40 sq ft excavation

12.0	14.0	20.0	26.0	30.0	35.0	20.0
0.0	1.3	2.5	3.0	4.0	4.5	0.0
	8.0	12.0	10.0	9.0	(−10.0)	

2)61.40
30.70 sq ft embankment

The foregoing is an efficient and accurate method for computing and checking cross-section areas.

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The First Tunnel Under the East River

TO THE EDITOR: The April program of the Metropolitan Section, at which the construction of the Queens-Midtown tunnel was described, reminded me of an unusual experience.

In 1894, I made my first trip to New York as a youngster with considerable experience, a job, and a limitless curiosity. Why the stock exchange should have attracted me is beyond conjecture. From the visitors' gallery, the scene of pandemonium on the trading floor below looked more like a battle royal in which each one slugs the first head in sight than like a meeting to barter stocks. Two men in the gallery were deeply interested. As I stood near them one turned to me, saw my blank expression, and said "Consolidated Gas is going down." Perhaps I said "Where?" Anyway by some strange impulse he took a card from his pocket, scratched a few words on it, and said, "If you are interested in knowing more about it, come to the foot of Wall Street at 3:00."

I did. A large steam yacht lay at the wharf. A small party came down the street and went aboard. The man who gave me the card said, "Come aboard. We are leaving at once." I did and he explained enough while going up the East River to key my interest to concert pitch.

We left the yacht at 71st Street, Manhattan, and I was in the first party of engineers and financiers to walk through a tunnel under either the North or the East River. It was built by the East River Gas Company to bring gas from a new plant to Manhattan. The financial story is too long to tell here. McMillan was the utility official who sensed a sincere interest on the part of a stranger. Charles M. Jacobs, the eminent English tunnel engineer, was chief engineer, and J. Vipond Davies was his assistant; both were later prominent members of the Society.

The tunnel, planned to be 8 by 10 ft in section, was about 120 ft below mean low tide and passed under Blackwell's (now Welfare) Island. It was thought that the rock would be solid at that depth, but a crevasse was encountered only 400 to 500 ft from the Manhattan shaft which required the use of an air lock and air pressures up to 50 lb. At maximum pressure shifts worked two hours, and under better conditions, four hours.

We flattened ourselves against the rough, irregular, unlined wall while the partition wall was blasted away. The alinement, which was carried about 1,300 ft from each shaft, compared with the accuracy obtainable today—that is to say, it was exact enough for the purpose. And that is a fair test of engineering and scientific ability. Less accuracy is negligence and means extra expense; more is also wasteful.

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SOCIETY AFFAIRS

Official and Semi-Official

Fall Meeting in Cincinnati to Open October 16

"The City" Is Theme of General Sessions; Five Technical Divisions Schedule Programs

At 10:00 a.m. on Wednesday, October 16, the 1940 Fall Meeting of the Society will convene in Cincinnati, Ohio, and from that time until the final curtain is rung down on Friday evening the program will be filled with social events and technical sessions appealing to a wide variety of interests.

Feeling that "the city itself" offers the most appropriate and timely theme for discussion, the Program Committee has selected that as the subject for consideration at the general meeting, and a number of papers on the Technical Division programs are also devoted to it. "A distaste for politics is traditional among engineers," states the committee, "but the responsibility for the proper functioning and the most desirable development of the modern city rests largely with the engineering profession, and the implications of that responsibility constitute the most important question now before us." The Committee goes on to point out that as cities grow in size, they tend increasingly to become "vast engineering projects," and that "growing awareness of this change has led to a feeling of mental confusion on the part of many intelligent citizens and their elected representatives."

Here is the skeleton program for the opening day:

Morning

Call to order; addresses of welcome; and response
The Progress of City Planning

Afternoon

The Civic Responsibilities of the Engineering Profession
Municipal Sanitation
Municipal Transportation

Evening

Dinner, address (The Function of the City), and dancing

On Thursday, October 17, the Technical Divisions take over. Morning and afternoon sessions are scheduled by the Power Division; morning sessions jointly by the City Planning and Surveying and Mapping Divisions; and afternoon sessions by the Highway Division and by the Sanitary Engineering Division. Topics, so far as they can be announced at this time, are as follows:

Power Division

The Long-Range Trend in Power-House Space Limits—How Accomplished, and the Economic Principles Involved
Water Passages, Intake Penstocks, Valves, Scroll Cases, Elbows and Draft Tubes—Progress and Economic Principles of Design
Turbine Speed Trend, American and Foreign, and Relation to Power Economics
The Measurement of Water in Connection with Plant Tests, High Head, and Especially Large Volume, Low Head
Cavitation Laboratory Practice, European and American
Ventilation and Generator Cooling

City Planning and Surveying and Mapping Divisions (joint sessions)

Specific Examples of Municipal Savings in Cincinnati, as a Result of the Master City Plan
The Topographic Map and City Planning

Highway Division

State and Federal Routes Through Municipalities
State Highway Planning Survey
Highway Research in Indiana

Sanitary Engineering Division

Toledo's Lake Erie Water Project
Historical Review of Development of Municipal Water Supply, Water Purification, Sewage Treatment, and Stream Pollution Control in Ohio

Lacking time for all of its general meeting papers on Wednesday, the Committee has scheduled an additional session on Friday morning, at which the "city" theme will be rounded out with presentation of the following topics:

The Esthetic Responsibilities of the Engineering Profession
Municipal Organization from the Engineering Viewpoint

Social Events and Inspection Trip

One social event—the dinner, followed by an address and dancing, on Wednesday evening—has already been mentioned briefly.

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New Water Treatment Plant Manual . . . . . p. 607

Cincinnati, Where the 1940 Fall Meeting of the Society Will Be Held

AERIAL VIEW OF ARMCO PLANT AT MIDDLETOWN, OHIO

An Inspection Trip Through These Great Mills Is a Highlight of the Fall Meeting Program

On Thursday evening a second such event will be held. A tour of the residential and park districts of Cincinnati is also planned, for Thursday afternoon, for the entertainment of the ladies and those members whose Divisions are not in session.

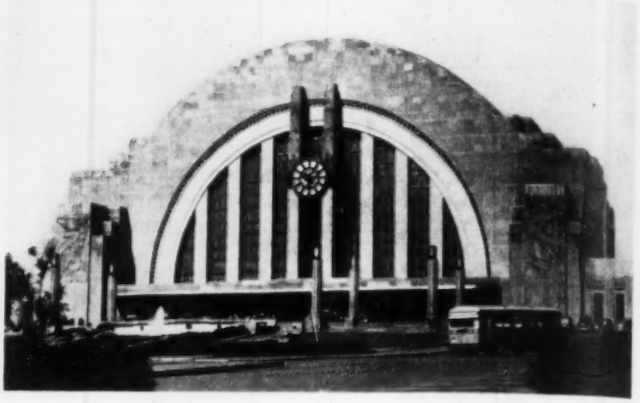
Special events for the ladies are in the hands of the Ladies' Committee, which announces a luncheon and sightseeing trip for Wednesday and a luncheon followed by cards and other entertainment on Thursday.

Final treat of the Meeting program is Friday afternoon's trip to the American Rolling Mills Company's plant near Middletown, Ohio, where members, ladies, and guests will see in operation one of the "miracles of the steel industry"—a continuous mill—as well as many other manufacturing processes, such as galvanizing, production of spiral welded pipe, and the finishing of stainless steel sheets and plates. They will also be privileged to visit the research laboratories adjacent to the plant. Following the inspection, the visitors will be guests of the Armco management at dinner.

OTHER EVENTS IN CONNECTION WITH THE MEETING

As usual, the regular conference of Local Section representatives from the Meeting region will be held in conjunction with the Fall Meeting. This conference, according to the present schedule, will occupy the entire day Tuesday, October 15.

Students will have their innings on Wednesday and Thursday, on both of which days a program of unusual interest for them has been arranged. Their general meeting comes on Wednesday, and Thursday will be given over to the regular Student Conference and presentation of student papers.



CINCINNATI'S UNION TERMINAL—AN IMPRESSIVE GATEWAY TO A GREAT CITY

Another View of This Terminal Is Shown on the Page of Special Interest in This Issue

The local committee is to be complimented on its plans for a most attractive meeting. The General Committee is headed by Hunter W. Hanly, and the chairman of the Technical Program Committee is Prof. Bartholomew J. Shine.

Details giving the names of authors and discussers, with complete information on social events, trips, and excursions, will be published in the October issue of CIVIL ENGINEERING.

For a meeting of broad technical interest and social and entertainment appeal—don't miss the Fall Meeting in Cincinnati.

Successful Convention Held in Denver, Colo.

Large Gathering Enjoys Fine Program of Extensive Meetings, Reclamation Exhibition, and Mountain Trips

COLORADO ENGINEERS, especially those in Denver, made a fine showing at the Society Convention, July 24 to 27, 1940. Arrangements worked out perfectly and were thoroughly enjoyed by a large number of local and visiting engineers and their guests. At its maximum, the registration reached about 950, exceeding the most optimistic hopes. For this particular week, the weather also scheduled an exhibition just to demonstrate what it would be like when the temperature reached almost par. By way of variety, the weather then moderated, so that the visitors could enjoy the more normal summer climate.

In arranging the program at Denver, the committee was faced with a predicament—to provide for an unusually full technical schedule and at the same time accommodate an inspection trip within the city together with a special mountain excursion. The result was an unusual sequence, consisting of technical meetings all day Wednesday and Friday, as well as Thursday morning. This

PART OF THE CONVENTION GROUP HAS ITS PICTURE TAKE

ONE OF THE GENERAL MEETINGS ON THE OPENING DAY OF THE SEVENTIETH ANNUAL CONVENTION

left Thursday afternoon for the open-house exhibit of the Bureau of Reclamation, Thursday evening for a special excursion into the nearby mountains, and Saturday for the all-day trip up Mt. Evans. The decision to make the social and sight-seeing features secondary to the technical sessions was subsequently justified, as indicated by the large audiences that listened to the engineering papers.

Interesting events preceded the meeting proper, so that in its larger aspects, at least, the Convention might be said to have started on Sunday, July 21. Following a number of committee meetings at the Brown Palace Hotel, Convention Headquarters, most of the early arrivals were privileged to enjoy the special garden party that evening. For this event, use of the sports lodge on the spacious Phipps estate on the outskirts of Denver had been secured. The beautiful estate, with its gardens, walks, pools, and fountains, not to mention its marvelous view of the Rockies, was thoroughly enjoyed. In addition the local engineers had arranged for the serving of a variety of refreshments. Such surroundings proved ideal for renewing old friendships and making new ones.

On Monday evening the local group and their ladies gave a dinner to visiting officers, committee men, and their families. The atmosphere was informal; the talks were few and brief. Aside from the excellent dinner, the main interest of the evening was in the eminently successful efforts of the local group to make their guests feel welcome and at home.

For Tuesday, conferences were arranged both in the morning and in the afternoon. A group of Juniors and one of Local Section delegates met independently in the morning. The two groups then joined forces for luenheon, which was attended also by most of the members of the Board of Direction. In the afternoon the Juniors and Local Section delegates met in joint session to consider matters of common Society interest.

On Wednesday morning, July 24, the Convention proper was officially opened. After suitable introduction, welcome, and responses, the President of the Society delivered his Annual Address, taking for his topic, "The Relation of the Society to National Defense." This address is being prepared for official publication in the current Society TRANSACTIONS, to be distributed in October. The morning session was adjourned in time for all to repair to a nearby hotel for a special lunch. At its conclusion, Past-President Crocker gave an interesting talk on "The History of the Local Section," or as he preferred to designate it, "A Section of Local History."

Upon return to headquarters, the large group, numbering over 300, convened for the afternoon session, which was devoted to a general consideration of government activities in reclamation. Because the engineering headquarters of the Bureau of Reclamation is in Denver, it was believed that this important work might well form a special feature of the Convention program; and this was arranged for. The Wednesday afternoon papers, which served as an introduction to the subject, dealt with general principles, planning, and construction, and were well illustrated.

Although only six of the Technical Divisions had planned programs, eleven sessions were scheduled; of these, three were conducted by the Soil Mechanics and Foundations Division. A large number of excellent papers were presented and generously discussed; many will later be published either in CIVIL ENGINEERING

TAKEN OUTSIDE OF HEADQUARTERS, BROWN PALACE HOTEL

A JUSTLY POPULAR EVENT FOR THE LADIES—LUNCHEON AT THE LAKEWOOD COUNTRY CLUB ON WEDNESDAY

or in PROCEEDINGS. The subject matter was concerned with the following topics:

Highway—Earth fills; state-wide planning; bridge engineering; and the Monarch Pass Project
Hydraulics—Madden Dam spillway; outlets for Grand Coulee; silt on the All-American Project; and Boulder Dam penstocks
Irrigation—Multiple-use projects; Mexican irrigation; salt problem; and consumptive use
Soil Mechanics and Foundations—Explosives for compaction; various theories and methods of soil mechanics; earth dams; and several reports by Division committees
Structural—Circular plates; earthquakes and structures
Surveying and Mapping—Cadastral engineering; Denver topographic survey.

While these meetings were going on, the ladies were being entertained delightfully at a variety of luncheons and teas, trips, and parties. They also participated in all the evening events as well as in the trip on Thursday afternoon. Perhaps the most notable event for the ladies only was the luncheon and afternoon entertainment on Wednesday at the Lakewood Country Club. If attendance is any measure, this event, which was elected by several times as many as had been expected, was by all odds outstanding.

For the formal dinner on Wednesday evening, a large ballroom in a hotel nearby was selected, where the air-conditioning provided comfortable surroundings. The dinner, like all others at the Convention, was excellent. Introductions following the dinner were limited in number. A male quartet provided a series of fine selections, including solos. One of the hits of the evening was a demonstration of old-fashioned dances by six local members and their ladies. During this period a surprise treat was inserted, consisting of flute solos by Otis E. Hovey, treasurer of the Society, accompanied by his daughter, Mrs. Ellen Hovey Davis. To many, this musical ability of an officer and Honorary Member came as a surprise; and to all it was a source of enjoyment. After the floor had been cleared, general dancing was enjoyed, both old and new style, with demonstrations and coaching by local members who were especially versed in these matters.

Engineers of the Bureau of Reclamation, so many of whom are stationed in Denver, took an important part in the committee work, in the presentation of technical papers, and in the entertainment. It was quite fitting, therefore, that the main city trip should have as its objective the headquarters of the Bureau. There on Thursday afternoon, an "open-house" was held. On the previous day officers of the Bureau as well as the President of the Society had taken part in opening this exhibition.

A complete tour had been arranged and an ample number of guides were on hand. There seemed to be displays of special interest to each individual—such as those on photoelasticity, concrete joints, triaxial tests, and model making. There was even a huge compression test demonstration involving a total pressure of 3,000,000 lb or more. Dioramas were exhibited as well as scale models of plants. Hydraulic tests were demonstrated with working models of siphons, dams, spillways, and valves. Problems in fish control were not overlooked.

No one could visit this impressive exhibit without being aware of the extensive preparation it had entailed. The variety and quality of the Bureau's engineering work were well set forth. One of the fine results was the opportunity it presented for the visitors to meet the personnel, many of them members of the Society. All agreed that the Bureau had put on a fine show.

Next on the schedule was another unusual event of an entirely different character. In the late afternoon the members of the group boarded a large number of buses which were waiting to conduct them to Central City, back in the mountains west of Denver. This picturesque and historic town was once the metropolis of the state and an active center for the mining of gold and other minerals.

Room Full of Scale Models Proves Interesting to Men and Women

Tiltometer Exhibit Is Demonstrated

AT THE OPEN HOUSE OF THE BUREAU OF RECLAMATION

Then came exhaustion, decay, and almost abandonment, although within the last few years increases in metal prices have revived the area to a considerable extent. Yet the atmosphere of the riotous mining era still surrounds the town. The visitor finds it easy to imagine that the pages of history have been turned back two-thirds a century and that the Colorado Gold Rush is on again in all its frenzied excitement. Again the historic Teller House rings with shouts and laughter. Again the storied "Face on the Barroom Floor" attracts its throng of admirers.

The trip was justly popular and no one seemed to be offended at the resulting crowding for dinner, which packed the hotel facilities. Following dinner, there was a special attraction in the nearby opera house, also a historic building, and justly popular for its excellent summer program. The Society and its guests almost monopolized the auditorium. A group of noted opera stars with supporting ballet, chorus, and orchestra, gave a fine rendition of Smetana's "Bartered Bride." The combination of excellent music, fine dancing, and hilarious plot was fully appreciated. It was with regret that the party left for Denver, which was reached long after midnight.

Several dozen visitors stayed over in Denver until Saturday in order to enjoy a trip to the summit of Mt. Evans, one of the highest mountains in the vicinity and accessible by road. Again the arrangements and schedule worked out perfectly. Individual members took as many guests as their cars would hold, making the trip consist of a number of social parties. The day was fine, in spite of the inevitable thunder showers. Such showers viewed from the summit added to rather than detracted from the interest of the trip.

En route the parties visited Golden, seat of the State Mining School, and then wound up nearby Mt. Lookout, from which they enjoyed a splendid view of the city. There also a stop was made at the museum and grave of Buffalo Bill. Without hurrying, the party reached the top of Mt. Evans about noon.

Part way down the mountain, the party stopped for dinner at the lodge on the shores of beautiful Echo Lake. Return was by way of the new Squaw Pass Highway an interesting and easy grade; then down Bear Creek Canyon, scene of torrential flooding a few years ago, and so to Red Rock Park not far from Denver. On account of its quaint formation, this tract belonging to the City of Denver proved most interesting. Opportunity was given to inspect the huge open amphitheater under construction there, situated among picturesque surroundings and unique rock formations. It will seat five thousand or more and provides a view of Denver itself across intervening hills and plains. Thence a short ride brought the party back to Denver, after ten hours of driving through superb mountain scenery.

Much of the success of the Denver Convention can be attributed to the efficiency and thoroughness of the local committee on arrangements. Committee members, both men and women, understood what was expected of them, and still more important, each scrupulously carried out his share of the work. Fine service was also rendered by members of the younger group. Other Sections may well follow the example of the Colorado Section in utilizing more fully the capable services of the younger members. Finally, great credit is due to the splendid committee of engineers from the Bureau of Reclamation, who planned and conducted its open house, one of the important highlights of this most successful Convention.

The Society and Construction Preparedness

DURING the spring and summer months the Society through its officers, or staff, has undertaken a variety of activities incident to National plans for defense. Some of the efforts and accomplishments have already been noted in the July and August issues.

References to this general topic formed the main subject of the Annual Address of President Hogan at the Denver Convention, entitled "The Relation of the Society to National Defense." It will be recalled that Colonel Hogan has been serving as chairman of the Construction Advisory Committee to the Army and Navy Munitions Board. Referring in his address to this work, he enumerated the general purposes and aims of this Advisory Committee as follows:

"(1) To secure proper legislation permitting the use of management contracts on fixed fees. This has been accomplished.

"(2) To prevent, as far as possible, the letting of agency contracts to manufacturing concerns to design, construct, and operate, because of our firm belief that this procedure would only result in confusion and, probably, scandal.

"(3) To have satisfactory forms of construction contracts approved for management construction. This has been accomplished.

"(4) To segregate engineering and architectural contracts from construction contracts. This has been established in principle in the Army and representations have been made to the Navy to correct some present difficulties.

"(5) To establish the principle that there shall be no competition in fees. This seems to be generally accepted but the situation needs watching.

"(6) To establish suitable regulations and forms for subcontracts of all forms. This has been accomplished in the Army but still remains unsatisfactory in the Navy where the engineer or architect, may be in the position of a sub-contractor.

"(7) To establish the principle of utilizing the services of existing engineering and architectural firms for design instead of expanding existing Federal organizations. This has been established in principle in both services but will be more utilized by the Army on account of its greater needs.

"(8) To urge as widespread geographical distribution as possible of technical and construction contracts to avoid overloading and favoritism. In this connection attention is invited to the practice of the architects in the New York City Working Development of taking in local associates to assist and share in the work of the principal architects.

"(9) To prevent undue migration of technical and construction personnel either between different government jobs or between these jobs and normal construction work already in progress or anticipated.

"(10) To insure adequate compensation for engineers and architects under the various classifications.

"(11) To insure adequate fees for consulting services."

The President's Annual Address, in its entirety, will appear in 1940 Society TRANSACTIONS.

CONSTRUCTION PREPAREDNESS CENSUS PROGRESS

From previous accounts in these pages, it will be recalled that the census for construction preparedness had three separate aspects: (1) the gathering of data with respect to firms or individuals in private practice; (2) the collection at various points around the country of lists of persons who might be readily available to augment existing staffs of those in private practice; and (3) the listing of names and addresses of those men between the ages of 30 and 45 deemed suitable to supervise construction as Captains or Majors in the Quartermaster Corps. These objectives have been pursued.

Forecast for September "Proceedings"

MAXIMUM PROBABLE FLOODS ON PENNSYLVANIA STREAMS

By Charles F. Ruff, M. Am. Soc. C.E.

Detailed record and explanation of a method for estimating the maximum probable flood from drainage areas of 100 to 6,000 sq miles.

SUPERSTRUCTURE OF THEME BUILDING OF THE NEW YORK WORLD'S FAIR

By Shortridge Hardesty, M. Am. Soc. C.E., and Alfred Hedefine, Assoc. M. Am. Soc. C.E.

Engineering problems involved in the design and construction of a 180-ft steel Perisphere and a Trylon taller than the Washington Monument.

As of Friday, August 16, copies of the returned questionnaires of 2,502 engineering firms or individuals in private practice, together with the names and addresses of 1,937 individuals, who have been suggested as suitable for commission in the Quartermaster Corps, had been forwarded to the Quartermaster General's Office. Of these latter, forwarded by the several Local Sections, 1,506 were not members of the Society. It has not been the attempt of the Society to confine any part of its census to members of this or any other Society. The attempt has been to render full service to any and all Federal agencies seeking information in regard to the engineering profession in all its branches.

As the second step in the census, it was suggested that Local Sections list those who might be immediately available locally to such private firms as were awarded engineering contracts. This feature has been found to be somewhat difficult of accomplishment. As a matter of fact, it now appears that there need be no intensive effort in this direction.

As these matters have developed during the past few weeks, a clearer perception has been gained as to the relationship and importance of the various governmental procedures. It now appears that the building of ships and the manufacture of fighting equipment are the first objectives to be sought by the government. Not until these shall have been determined upon in rather definite terms will construction in relation to them be necessary. Production contracts for munitions and implements of war have seemed to be awaiting action by Congress, more particularly with respect to the proposed tax bills and the several provisions which they are to contain.

Engineers, therefore, should not expect a great volume of construction work to be put under contract until these legislative matters are settled, and perhaps even then the total may not aggregate more than was performed under the PWA before its operations were curtailed. Furthermore, it appears that the various services in the Federal Government related to defense construction are now well supplied with data accumulated by the census. Apparently, therefore, all the steps that are needful in connection with the census have been taken at this time.

Staff Member to Washington in Interest of Civil Engineers

RESPONDING to action by the Board of Direction at its recent meeting held at Denver, "that a member of the staff spend as much time as necessary in Washington, particularly during the next few months, to look out, in all practicable ways, for the interests of civil engineers," W. E. Jessup, Field Secretary, took up temporary residence in Washington on July 31.

A number of matters affecting civil engineers, as to fees, salaries, and fields of work in relation to other professions have long been dealt with as from a distance, but now are to be approached more at first-hand and with the knowledge and enthusiasm of one experienced as a civil engineer. The matter of expanding the mapping program is a specific instance, although the present does not appear to be a propitious time to press this matter with any considerable confidence of a favorable outcome.

Study of the forms of contract, definition of "costs" and determination of payments for engineering and architectural services rendered under the defense program, is a matter more especially of the moment. Also, it will be urged that the salaries to be paid to engineering employees engaged in this work, either by private employers under contract to the government or within the several government administrative services, conform to those indicated in the Grading Plan and Compensation Schedule adopted by the Board of Direction.

Another long-time desire which has not been attained is the cessation of the practice by the federal government, or by at least two of its agencies, of requiring competitive price bids for the surveying work in connection with structures erected by the government or with the aid of federal money. Award on the basis of merit will be urged.

These are but a few of the objectives to be approached. In all appropriate ways the principles set forth by the Construction Advisory Committee to the Army and Navy Munitions Board, of which President Hogan is chairman, will be supported. These principles are detailed elsewhere in this issue.

It will not be a part of Mr. Jessup's work to secure jobs for any individuals or firms. However, as requests may be made of him in such connection by proper officers of the various federal services, he and the Headquarters office will make every effort to provide all available data through the biographical records in the Society's files or that can be secured from reliable sources. In no sense, therefore, is he to be regarded as an agent of an employment service but, on the other hand, he may be regarded as one who, wherever he sees the interests of civil engineers prejudiced, will use his best efforts in their behalf.

A committee has been appointed by the District of Columbia Local Section to assist him on any of the objectives which he may seek to attain, or to suggest to him matters relating to civil engineers which appear to that committee as in need of rectification.

Clarification of Goverment Cost-Plus-Fixed-Fee Contract Procedure

The following excerpts are from information released by the office of the Quartermaster General on August 15, "with a view to clarifying a number of points and misunderstandings related to cost-plus-a-fixed-fee contracts."

WHENEVER it is in the public interest to commence work without waiting for the development of design and plans to the extent that is necessary if a lump-sum proposal is to be intelligently formulated, the cost-plus-a-fixed-fee type of contract provides a form of agreement under which the work can be commenced at once, and the successive steps of construction can proceed as the successive steps of design are developed and reduced to working plans.

A cost-plus-a-fixed-fee contract is awarded as a result of negotiation with a selected contracting firm. For some months a special group in the Quartermaster General's office has been and still is collecting and compiling data pertaining to the architectural and engineering firms and constructing organizations that are known to be willing to participate in the current national defense program. The analysis of these data provides ready information respecting the organizational, plant, and financial resources of these firms, the nature and scope of their past achievements, etc., all of which is essentially necessary in measuring the qualifications and capabilities of the prospective contractors.

The War Department will give consideration to all qualified contractors, architects, and engineers interested in the defense construction program and will furnish, upon request, a detailed outline of information required for qualification. After prospective contractors, architects, and engineers have filed their experience records they will be given every consideration when the selection for any particular project is made, and those who so desire may personally present their credentials to the Office of the Quartermaster General. It is not considered advisable or necessary that they remain in Washington with resultant loss of time and expense, or return for further consultation until called in by the War Department for negotiations in connection with some particular project.

When authority is given for the accomplishment of a given project under this type of contract, a study is made of the data above mentioned, and there is selected therefrom the firm that appears to be the best qualified to undertake and satisfactorily complete the contemplated work. This selected prospective contractor is then invited to enter into negotiations and when such negotiations have reached the point where the Government and the contracting firm are agreed as to what is to be done and the fee to be paid therefor, the name of the firm and the agreed-upon fee are submitted to the Advisory Commission to the National Defense Council for clearance. If cleared, the terms and conditions are translated into a formal contract which, when signed by the parties, is presented to the Assistant Secretary of War for his approval. Work is commenced promptly after approval of the contract. All information relating to the various steps between the time of authorizing the project and the time of the actual approval of the signed contract is treated as a confidential matter.

It has come to the attention of the War Department that certain individuals are alleging that they have influence and are able to assist interested contractors, architects, and engineers in securing contracts awarded by the Quartermaster Corps. These statements of alleged influence are without foundation, as contractors, architects, and engineers will be selected solely on the basis of their experience and qualifications, and ability to render service of value to the Government in connection with any particular project. Nothing is to be gained by contractors, architects, and engineers

personally or otherwise soliciting this office after filing their experience records. Any funds expended for the hire of persons for this purpose is wasted.

Awards of negotiated fixed-fee contracts are primarily based upon the interests of the Government after due consideration of relative experience and merit of the selected contractor. Final decision respecting relative qualifications is determined in the Office of the Quartermaster General. Unless a deviation therefrom presents a special advantage to the War Department, it is the policy to make awards to qualified firms in the geographical area in which the work is to be performed. All things being equal, the awards will be spread out as far as possible; an award of more than one contract to any one firm is not contemplated unless the interests of the Government dictate a necessity for such action.

The formation of organizations to handle work not normally performed is discouraged. Each project represents the coordinated work of specialists in generally recognized trades. It is desired to select an organization (either one or a combination of firms) which normally executes the most important phases of work with its own forces. It is contemplated other phases generally executed on so-called subcontract arrangement will be handled either on cost-plus-a-fixed-fee or lump-sum basis, when to the interest of the Government.

To date approximately 1,900 firms have filed their experience records and evidenced interest in the probable 80 projects to be awarded on negotiated fixed-fee basis. Under these conditions it is obvious all applicants and qualified firms will not be able to secure work.

Mid-South Section Urges Use of Qualified Engineers on Public Works

A RESOLUTION urging that design by registered professional engineers be made a prerequisite to the sponsorship of public works by governmental agencies was adopted by the board of directors of the Mid-South Section at Memphis on July 12, 1940. The complete resolution follows:

"WHEREAS, it has come to the attention of the Board of Directors of the Mid-South Section of the American Society of Civil Engineers that federal, state and other governmental agencies in the Mid-South area are in certain instances participating in the financing of public engineering works and in the construction of such works, without the design first being prepared by properly qualified professional engineers and the subsequent execution supervised by properly qualified professional engineers or that either or all conditions have been disregarded, and

"WHEREAS, it is deemed contrary to the public welfare that such practice be continued in that hazard to life and property may be incurred and that sound economic policy demands that all public works be designed and constructed by those trained and experienced in the engineering profession,

"*Therefore, be it resolved*, that the Mid-South Section of the American Society of Civil Engineers call the attention of the proper authorities to the condition existing and request their cooperation in that the sponsoring of engineering works by their respective agencies be made contingent on the receipt of plans, specifications and estimates properly prepared by registered professional engineers and that the execution of such works be likewise placed under the supervision of personnel properly qualified for the exercise of such duties."

Tellers' Report on First Ballot for Official Nominees

To the Secretary
American Society of Civil Engineers

August 1, 1940

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

For Vice-President, Zone II	
Charles Henry Stevens	453
Scattering	52
Void	9
Blank	6
Total	520
For Vice-President, Zone III	
Charles Baker Burdick	557
Scattering	55
Void	22
Blank	14
Total	648
For Director, District 3	
Solomon Cady Hollister	88
John Whitfield Cowper	69
Scattering	2
Void	7
Total	166
For Director, District 5	
Gustav Jaeger Requardt	143
Scattering	15
Void	9
Blank	1
Total	168
For Director, District 7	
William Nelson Carey	151
Scattering	11
Void	11
Blank	2
Total	175
For Director, District 8	
George Bragg Massey	141
Scattering	14
Void	10
Blank	1
Total	166
For Director, District 9	
Ralph Benjamin Wiley	62
George Nelson Schoonmaker	34
Scattering	11
Void	7
Total	114
For Director, District 12	
Claude Irving Grimm	51
John Wilbur Cunningham	26
Scattering	8
Void	10
Blank	1
Total	96
For Director, District 16	
Ernest Emmanuel Howard	81
Lowell Edwin Conrad	47
Scattering	7
Void	11
Blank	1
Total	147
Ballots canvassed	2,200
Ballots withheld from canvass	
From members in arrears of dues	
Without signature 6	
Illegible signature 1	81
Total number of ballots received	2,281

Respectfully submitted,
E. WARREN BOWDEN, *Chairman*

F. V. Hayes
M. S. Spelman
Ivan Rosov
John J. Kelly
A. C. Josephs
H. F. Hormann
Harris Grand
Francis S. Harvey
Frederick W. Ockert
Joseph Farhi
C. P. Melioransky
Harry T. Immerman
William H. Mueser
Edward N. Whitney
Harold W. Knox
Richard McK. Hodges
Tellers

Are Enough Students Being Trained in Civil Engineering?

Data Presented Here Indicate a Deficiency—at Least in Comparison with Other Branches of the Profession

By RICHARD G. TYLER, M. AM. SOC. C.E.
and ROBERT G. HENNES, ASSOC. M. AM. SOC. C.E.

RESPECTIVELY PROFESSOR OF SANITARY ENGINEERING AND ASSISTANT PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF WASHINGTON, SEATTLE, WASH.

IN THE COURSE of an investigation made recently for the Seattle Local Section of the American Society of Civil Engineers, data on the relative number of men engaged in the various branches of engineering in the State of Washington were assembled. When these data were considered in conjunction with the number of engineering students being graduated from the state's engineering colleges, it was apparent that the distribution of graduates among the various fields of engineering was not at all in keeping with the distribution of existing engineering positions. The question naturally arose as to whether the engineering colleges and the profession as a whole were advising students adequately concerning the relative opportunities for employment in the various branches of the profession. The writers consider the matter of sufficient importance to be called to the attention of the civil engineering profession. The statistics, while meager, are still sufficiently conclusive to show trends that should be given consideration.

Figure 1 shows the number of technical engineers gainfully employed in the United States as given in the reports of the Bureau of the Census for 1920 and 1930, respectively. These data would be more significant if each major engineering division were listed separately, instead of being grouped in the four categories shown. However, the figure shows the very considerable predominance of civil engineers and surveyors as well as the relative numbers of those in other categories.

Figure 2 shows data on the number of gainfully employed technical engineers in the various categories in the State of Washington. This parallels the general trends shown in Fig. 1, but indicates an even greater proportion of civil engineers and surveyors. These data are reproduced, not because they accurately represent the number of engineers of each category in the state, but because the data concerning the number of registered engineers and surveyors in the state are available and can be compared with them as a check on trends since the last census. Figure 3 shows the division of the registered engineers of the State of Washington (1939) into the different categories and further emphasizes the preponderance of civil engineering positions. The distribution here shown is undoubtedly influenced by the several large federal construction projects that are under way locally, on which the majority of engineering positions are in the field of civil engineering. This statement, however, does not apply to the census data shown in Fig. 2, since those projects had not been started in 1930.

It is a well-known fact that the number of men in aeronautical and chemical engineering has increased much more rapidly since 1930 than prior to that date. It is hoped that the 1940 census will report these two fields separately. The number of members of the four national Founder Societies, as given in their 1939 year books, while not indicative of the total relative numbers of engineers in their respective branches of the profession, are of interest. They were as follows: civils, 16,008; electricals, 16,626; mechanicals, 14,000; and mining, 9,614.

Turning now to the data concerning the number of students being graduated in the various fields of engineering, Table I shows the distribution of graduates for the years 1930 and 1938 for the State of Washington and for the United States as a whole. If we think of these data as indicating the supply of young engineers adequately trained for prospective jobs, it is interesting to compare them with the demand for engineers as represented by the figures of gainfully employed engineers given by the 1930 census. Table II gives this comparison and indicates that less than half the proportionate number of civil engineers was being turned out in 1930, while the number of electrical engineering graduates closely paralleled the demand. The rapid increase in the percentage studying chemical and mining engineering that has occurred during the last decade in the State of Washington is shown in Table I. The rapid drop in the relative proportion of electrical engineers is also shown. The 1940 census will probably show some interesting figures in this connection. Table III, giving the enrolment of 146 engineering schools, shows the relative number of

TABLE I. CLASSIFICATION OF ENGINEERING GRADUATES (1930 AND 1938)

BRANCH OF ENGINEERING	PERCENTAGE IN EACH CATEGORY		
	U.S.	State of Washington	
	1930	1930	1938
Aeronautical	3.5	3.8	7.7
Chemical	20.5	4.5	15.9
Civil	20.5	16.7	21.8
Electrical	22.9	49.3	24.8
Mechanical	25.1	13.6	15.9
Mining	7.5	3.8	14.5
Miscellaneous	....	8.3	....

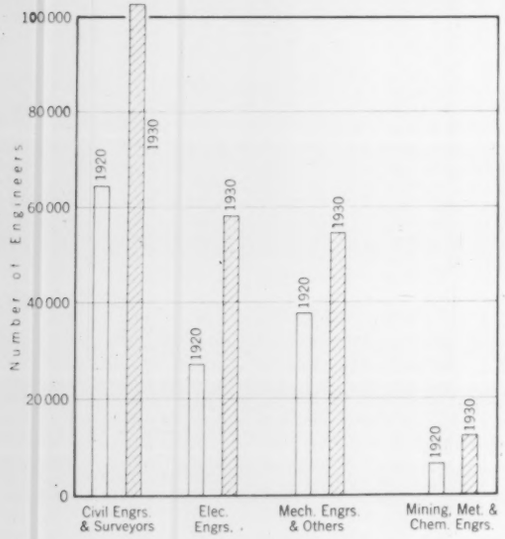


FIG. 1. GAINFULLY EMPLOYED ENGINEERS IN THE UNITED STATES IN 1920 AND 1930, AS REPORTED BY THE U.S. CENSUS

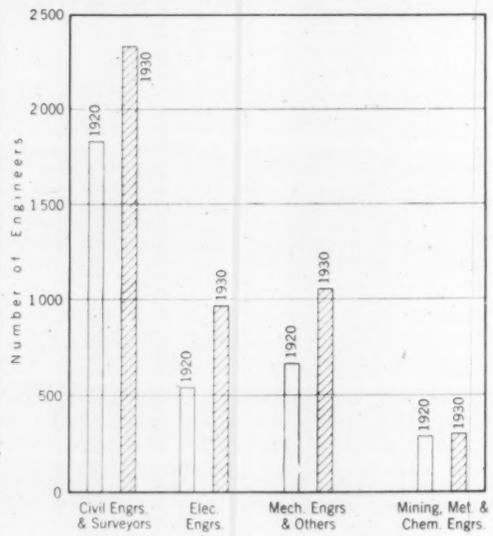


FIG. 2. GAINFULLY EMPLOYED ENGINEERS IN THE STATE OF WASHINGTON IN 1920 AND 1930, AS REPORTED BY THE U.S. CENSUS

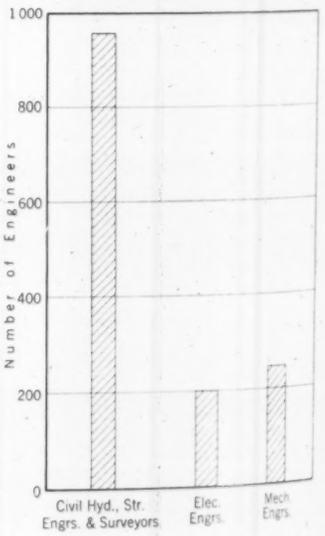


FIG. 3. REGISTERED ENGINEERS IN THE STATE OF WASHINGTON, 1939

students in the four major groups, standing numerically in the sequence, mechanical, electrical, chemical, and civil (1939); while the demand follows the sequence, civil, electrical, mechanical, and chemical plus mining (1930).

From what sources are the men occupying civil engineering positions being recruited, since they are apparently not being provided by the departments of civil engineering in the engineering colleges throughout the country? The census report helps us to answer this question. It states that 8% of those engaged in civil engineering in 1930 were trained in other branches of engineering,

TABLE II. RELATION BETWEEN SUPPLY OF ENGINEERS AND DEMAND FOR ENGINEERS

BRANCH OF ENGINEERING	THE SUPPLY (GRADUATES)—% IN EACH CATEGORY			THE DEMAND (GAINFULLY EMPLOYED)—% IN EACH CATEGORY	
	U.S. 1930	State of Washington		U.S. 1930	State of Wash. 1930
		1930	1938		
Civil	20.5	16.7	21.8	45.2	54.8
Electrical	22.9	49.3	24.2	25.5	22.7
Mechanical and Aeronautical	28.5	17.4	23.6	24.0	15.7
Mining, Metallurgical, and Chemical	28.1	8.3	30.4	5.3	6.8
Miscellaneous	....	8.3	....	....	....

15% were men who had not completed their engineering courses, and 11% were without any formal engineering education whatever. These figures exceed similar figures for all other departments, though mechanical engineering is a close runner-up. To have 34% of all civil engineers entering the profession with inadequate or no training is a matter that should challenge the attention both of the schools and of the profession. The writers believe that the responsibility for this situation must be shared by both. Educators are at fault in so far as students are misled by the over-enthusiastic statements of certain instructors found on every college staff, into overcrowding certain recommended departments at the expense of others less well advertised. The profession is responsible in so far as it employs untrained or inadequately trained men when it could demand and receive an ample supply of men with proper training.

There is a natural conflict of interest between practicing engineers and engineering students, since the greater the number of graduates, the more intense the competition in the profession, with a corresponding decrease in the income from professional services received by any one individual. The increasingly rigorous application of registration or licensing laws probably springs from a desire to raise professional standards, but it would be more difficult to enforce were it not in accord with the economic interests of practicing engineers. Engineering educators have similarly found their individual interests frequently opposed to those of practicing engineers in the same field. They also find themselves too frequently in conflict with their colleagues in other departments of engineering, since an increase in the number of students in a department tends to facilitate advancement in rank and salary increases for the instructors in that department.

Caught in this interplay of clashing interests, the engineering freshman attempts to select the branch of engineering that offers the best opportunities for his particular talents. It would be something of a coincidence if the majority of these young men were to choose rightly from the limited and conflicting sources of vocational guidance available to them. Engineers and educators share a responsibility to the men who will later constitute the engineering profession, and it is a healthy practice to examine occasionally, with a minimum of self-interest, the manner in which that responsibility is being discharged.

There are, of course, other factors that influence the prospective engineering student in selecting his field. Opinions of family or friends, descriptions in the press of engineering projects of local or national interest, or a facility for repairing the radio or other household appliances, may be major factors in making this choice. One should not forget, also, that certain phases of engineering activity have a greater appeal to the imagination of American youth than others, and this undoubtedly attracts more students to the aeronautical, chemical, and electrical fields in proportion to the real need than to civil, mechanical, and mining. But whatever the cause of the discrepancy between supply and demand, it is obvious that both the public and the engineering student suffer. From the standpoint of the public, engineering positions are not always filled with the best-trained men; from the standpoint of the student, graduates trained in overcrowded fields of engineering must seek opportunities in other branches for which they are inadequately trained. With some degree of justification they may criticize their educational advisers for not having presented to them an accurate view of the situation so that they could have secured the education affording the best preparation for the positions available.

Attention should be called again to the fact that at least 11% of the men in active civil engineering practice are without any formal engineering education whatever. The profession as a whole is largely responsible for this situation in that men unqualified by education are being employed in minor positions when frequently men with engineering training are available. Some of these men continue in the engineering profession and may eventually even attain some degree of eminence in it. This does not mean that technically trained men who should have been employed in their places, might not have obtained even greater eminence and rendered more adequate service to the community and to the profession.

The writers recognize that the statistics used as a basis for these comments are meager and incomplete, but believe that certain definite trends are clearly indicated. These are already known to many engineering educators, but the civil engineering profession itself should also give thoughtful consideration to the fact that the discrepancy between the number of graduates and the number of positions available is greater in the civil engineering field than in other branches of the profession. It is a matter that affects the welfare of the profession.

While to give entering engineering students more accurate and definite information concerning the relative numbers of replacements needed in the various engineering fields is of importance to the entire engineering profession, it is of special importance to the American Society of Civil Engineers as the national organization most adversely affected by the existing situation.

TABLE III.* ENGINEERING ENROLMENTS, 1939–1940

(153 institutions giving instruction in engineering were requested to furnish the following information; 146 had replied as of December 30, 1939)

ENGINEERING COURSES	FRESHMEN (1ST YEAR)	SOPHOMORES (2ND YEAR)	JUNIORS (3RD YEAR)	SENIORS (4TH YEAR)	5TH YEAR (OF 5-YR CURRICULUM)	SPECIAL STUDENTS	EVENING STUDENTS	OTHERS	TOTALS
Aeronautical	972	808	599	503	26	2	119	5	3,034
Agricultural	223	296	229	195	..	3	5	..	951
Architectural	290	247	205	169	2	1	..	..	914
Ceramic	152	177	148	134	..	44	..	..	655
Chemical	3,972	4,188	3,316	2,955	228	54	543	12	15,268
Civil	2,601	2,858	2,496	2,335	114	48	616	23	11,091
Electrical	3,759	4,044	3,526	2,906	157	66	1,214	8	15,680
General	932	605	378	332	31	5	371	2	2,656
Industrial	340	579	597	622	34	5	126	..	2,303
Mechanical	5,987	6,866	5,345	4,245	255	100	1,695	398	24,891
Metallurgical	349	605	505	550	7	5	231	4	2,256
Mining	526	592	581	552	1	10	7	..	2,269
Unclassified	11,694	2,319	1,627	1,284	22	115	6,697	176	23,934
Totals	31,797	24,184	19,552	16,782	877	458	11,624	628	105,892

*Taken from page 449 of *The Journal of Engineering Education* for January 1940.

Meeting of the Board of Direction—Secretary's Abstract July 22–23, 1940

THE BOARD of Direction met at the Brown Palace Hotel, Denver, Colo., July 22 and 23, with President J. P. Hogan in the chair, and Secretary Seabury and the following members of the Board in attendance: Past-Presidents Riggs and Sawyer; Vice-Presidents Ferebee, Davis, Jacobs, and Lucas; and Directors Agg, Anderson, Ayres, Blair, Bres, Brooks, DeBerard, Dunnells, Goodrich, Harrington, Hudson, Hyde, Leeds, Lewis, Parker, Polk, Root, White, and Treasurer Hovey. Regrets were received from Director Sawin.

Approval of Minutes

Minutes of the meeting of the Board held on April 15, and of the Executive Committee on April 14, were approved as written.

Executive Committee Action

Decisions of the Executive Committee acting with power were approved by the Board. Other matters from the Committee, referred to the Board with or without recommendation, are included in the Minutes of the Board.

Local Section Constitutions

Revisions or amendments to the constitution and by-laws of the following Local Sections were approved: Florida, Sacramento, San Francisco, and Seattle Sections.

Freeman Scholarship Awarded

Confirming the recommendation of the Committee on Freeman Scholarship, H. G. Dewey, Jr., Jun. Am. Soc. C.E., of Denver, Colo., was appointed to the John R. Freeman Scholarship for the coming year, as mentioned in the news item in the August issue, page 535.

Alfred Noble Prize

The Alfred Noble Prize for the next three years was fixed at $350 annually.

Proposed Change in E.C.P.D.

Approval was given to a suggested change in the charter of the Engineers' Council for Professional Development to permit the inclusion of the Engineering Institute of Canada as a participating body, such action being contingent on similar approval by other participants in E.C.P.D.

Advertising by Local Sections

The Committee on Publications proposed a restatement of policy to avoid conflict between advertising in the Local Sections' and in the Society's publications. The following statement was approved:

"The policy of the American Society of Civil Engineers with respect to advertising in publications of the Society and in its Local Section publications shall be as follows:

"1. CIVIL ENGINEERING shall be the only publication of the Society accorded the privilege to solicit or to carry advertising from industrial, engineering, or commercial concerns doing a nation-wide business, except as provided in paragraph 2.

"2. Periodicals established by Local Sections of the Society may solicit advertising from local contractors, local manufacturers of material or equipment, and similar industrial concerns doing business in a restricted geographic area. Local Sections are requested not to solicit advertising from those concerns whose advertising appears in CIVIL ENGINEERING, or from national manufacturers, their branch offices, or their exclusive local dealers; nor to carry such advertising except with the approval of the Committee on Publications."

Cases of Professional Conduct

Several cases involving ethics were brought to the Board by the Committee on Professional Conduct. One such instance resulted in expulsion from membership in the Society.

Engineering Societies Personnel Service

In connection with the change of the Engineering Societies Employment Service to the Engineering Societies Personnel Service, Inc., already approved by the Board, action was taken to make authoritative the necessary transfer of functions and property. In so doing, the Board accepted responsibility for helping in administration and finances.

Civilian Protection

The Board was in receipt of a petition signed by 44 corporate members regarding the formation of a "Division on Air Protection." It was the judgment of the Board, however, that instead of forming a new Division, it would be better to appoint a Special Committee on Civilian Protection and this was authorized. The scope of the Committee was defined as to assist "in all matters relating to civilian protection; the safeguarding of life and of civilian activities in general and the protection of public utilities." Formal proffer of the services of this committee is to be made to the Government "in the study of the engineering problems involved and in the formulation and suggestion of procedures deemed most effective as protective of the civilian population."

Committee on Hydrology

Following recommendation of the Committee on Division Activities, the Hydraulics Division was requested to institute a Committee on Hydrology and to secure suitable papers on the subject.

Construction Preparedness

Report of details of the Society's activities in connection with construction as related to the defense program was read and received approval.

Salaries

Report of the Committee on Salaries was received and the Board approved of policies applying to requests for assistance with regard to salaries by groups of engineers.

Society Representative in Washington

The Board approved the recommendation of the Committee on Professional Objectives that a member of the staff "spend as much time as necessary in Washington, particularly during the next few months, to look out, in all practicable ways, for the interest of civil engineers."

Salary Survey—Nevada State Highway Department

Request of the Sacramento Section was approved, to the effect that the Society cooperate in a salary survey of engineers in the Nevada State Highway Department, contingent upon proper arrangements with that department.

Withdrawal from American Engineering Council

It was voted "that American Engineering Council be notified of the intention of the Society to withdraw at the end of this year."

Board Routine

As a matter of regular practice, the Board considered various matters having to do with membership, finance, accounting, and similar items, in each case taking action deemed advisable under the circumstances.

Adjournment

Adjournment was taken to meet in Cincinnati, Ohio, on October 14, 1940.

Committee on Interstate Water Rights Commended for Report

AT THE MEETING of the executive committee of the Irrigation Division at Denver, in July 1940, a resolution was passed commending the work of the Committee on Interstate Water Rights as represented by its final report, published in the 1939 volume of TRANSACTIONS.

The report referred to covers the history of the adjustment of the use of the waters of interstate streams, principles controlling such rights, methods of adjudication by court or compact procedure, and the status of such rights on many streams. Twelve years in preparation, it has required a large amount of work by the Committee and represents a distinct contribution in this field. In recognition of this service, the executive committee of the Irrigation Division expressed the appreciation of the Division for the work of the Committee and the value of the results accomplished.

It was the opinion of the Division's executive committee that any engineer having to do with irrigation or related matters, and not already familiar with this report, would do well to review its valuable findings.

Manual on Water Treatment Plant Design

CULMINATING the work of more than five years, the Committee of the Sanitary Engineering Division on Water Treatment Plant Design has produced a manual of 128 pages which should serve as an authoritative guide to this subject for a long time. It will be placed in the hands of members shortly through the regular mail.

The manual is divided logically into five chapters, plus a bibliography of 287 references. Chapter 1 concerns the general arrangement of a water treatment plant, including the questions of financing and design problems. Types of filters and methods of water softening are also discussed. Then follow, in Chapters 2 and 3, discussion of aeration and examples of aerators, structures, and apparatus for primary treatment, sedimentation, and filtration. Chapter 4 concerns chemical agents used in treatment processes; and the final chapter deals briefly with the hydraulic problems involved.

Under the chairmanship of Joseph W. Ellms, the committee comprised James W. Armstrong, Joseph D. De Costa, Arthur E. Gorman, George W. Hamlin, Eugene A. Hardin, Aaron G. Levy, the late Arthur L. Reeder, and Frank H. Stephenson, all members of the Society.

Distribution to the Society membership will, as usual, be gratis. Extra copies will be available at $1.90 each, with the usual discount of 50 per cent to members.

Engineering Jobs Go Begging in Detroit Area

MANY engineering positions received by the Detroit office of the Engineering Societies Personnel Service, Inc., since its opening on July 1 in the Hotel Statler are unfilled because of a lack of registrants, reports L. E. Williams, manager of the office. He urges the participating societies in the Service to call this fact to the attention of their members in the Detroit area so that those who are unemployed or wish to change to a better position may register immediately in person or by mail. It is expected that a great many more positions in all fields of engineering will become available in September with the start of production on the 1941 automobile, and on the many government contracts for national-defense material.

L. B. Lent New Secretary of American Engineering Council

COLONEL L. B. Lent, engineer, inventor, and trade association executive, has been appointed executive secretary of the American Engineering Council and will assume his new duties immediately. He succeeds Frederick M. Feiker, who resigned several months ago to become dean of engineering at George Washington University.

Colonel Lent is a native of Brewster, N.Y., and a graduate of Stevens Institute of Technology. After five years as associate editor of *Power*, his studies of gas-engine development led to an association with the Riverside Engine Company, and later to his employment by the Ford Motor Company as assistant chief engineer of construction and maintenance.

Entering the Army during the World War, he was assigned to the development of airplane engines at the Curtiss plant in Buffalo, subsequently being transferred to Langley Field as engineer officer and later to Camp Vail as commanding officer of Air Service Troops at that field. He subsequently had command at Brindley Field and Roosevelt Field. After the war he became superintendent of the U.S. Air Mail Service, during which engagement he organized the first transcontinental service from New York to San Francisco.

Colonel Lent entered trade association work as chief engineer of the Common Brick Manufacturers' Association of America. He later became executive officer of the Scientific Apparatus Makers Association, writing and administering the NRA code for the 500 members of this industry. He was then made president of the Panoptik Company. More recently, he has been a consultant in the aviation field, especially as engineer to the Aeronautical Development Commission of the State of Connecticut.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

COMMITTEE WILL ADVISE ON PAN AMERICAN RELATIONS

RESPONDING to an invitation by the Department of State, Colonel L. B. Lent, executive secretary of American Engineering Council, and C. O. Bickelhaupt, chairman of its Committee on Inter-American Engineering Relations, on August 1 conferred with Charles A. Thomson, Harry H. Pierson, and Richard Pattee, of the Division of Cultural Relations, relative to specific methods by which the committee can lend its advice and assistance to the State Department. The discussion centered about facilities for the introduction to the profession of engineers arriving from abroad, specifically the eight Latin-American students soon to arrive in this country to attend the Farm Equipment Seminar, as well as others expected to come later under the exchange plan now being inaugurated. The committee was also asked to consider the problem of securing applications from qualified engineering teachers for exchange professorships under this same plan, for which funds are now available.

The State Department has asked Council to broadcast the information among its members that many requests are being received from abroad for informative educational motion picture films reflecting the life, ideals, and customs of the United States. While a certain number of government films are available, the Department could meet these requests more adequately if it had available for distribution films of this type produced by other than government agencies, and it is hoped that these will be made available by those who have them.

SUPPLIES FOR 2,000,000 AND TWO-OCEAN NAVY NOW GOALS IN NATIONAL DEFENSE

Approval by Congress of an expanded U.S. Navy exceeding in size the combined present fleets of Great Britain and Japan, announcement of the financing of a new plant that will double present production of high-power aviation engines, and assurances from William S. Knudsen of the National Defense Advisory Commission that this country is industrially able to equip a force of 2,000,000 fighting men, were high spots of an eventful month in Washington.

Few persons realize the complexity of the task of supplying a modern army and navy. Unofficial estimates place the number of needed articles at 70,000, of which all but some 3,700 are commercially manufactured. Most of these latter can be manufactured in existing plants at the cost of some disturbance to normal operations; it is this type of article that has been the subject of recent educational orders to accustom selected manufacturers to their quantity production when this becomes necessary. During recent years the War Department has inspected 20,000 commercial plants to procure definite knowledge of their equipment and capacity, and has assigned definite products to 10,340 of these. There still remain, however, some 200 critical items requiring highly specialized equipment or methods not applicable to peace-time uses; these must be produced in government-owned plants. Thus the Army's plans for a major military emergency include the erection of 78 ordnance, 28 chemical, and 2 quartermaster plants at a total cost of over $600,000,000. Congress has already earmarked approximately this amount for such construction.

Aside from the building of this type of plant there is sure to be considerable expansion of private facilities, particularly in the aviation industry. Not only is the United States determined to build up its own air forces, but the British have announced their desire to buy planes at the rate of 3,000 per month for the next two years, and their willingness to finance the plant expansion necessary to attain this goal. The first defense plant construction loan to be

approved by the Reconstruction Finance Corporation was for a $92,000,000 plant for the Wright Aeronautical Corporation, to be located near Cincinnati, Ohio. This will turn out 12,000 airplane motors annually, virtually doubling present American production capacity.

ADVISORY COMMITTEES NAMED

To avoid overloading the construction industry in any one locality and to generally coordinate and advise on plant and construction problems, the Army and Navy Munitions Board has appointed a civilian committee of construction experts with the following members: Col. John P. Hogan, president of the American Society of Civil Engineers (chairman); Alonzo J. Hammond, president of American Engineering Council; E. J. Harding, general manager, Associated General Contractors of America; E. P. Palmer, past-president of the Associated General Contractors; Malcolm Pirnie, chairman of the Construction League; Stephen F. Voorhees, past-president of the American Institute of Architects. [See Civil Engineering for August, p. 534.]

A second committee of civilian experts has been named by the War Department to speed up the negotiation of construction contracts. This advisory section will recommend, for each building job, three firms which appear best qualified to perform the work; the Department will then attempt to negotiate a contract with one of these on a cost-plus-fixed-fee basis. Appointments to the committee so far are: Francis Blossom, of Sanderson and Porter, New York; Forrest S. Harvey, recently with Lee, Hill, Barnard and Jewett, Los Angeles; and F. J. C. Dresser, Cleveland, director of the American Construction Council. Two other members are yet to be named.

PROFESSIONAL STATUS DEFINITION ARGUED

Several days of hearings before an examiner of the Wage-Hour Division of the Department of Labor on proposed definitions for professional, administrative, and other types of workers exempted from the provisions of the Fair Labor Standards Act brought forth a number of conflicting views as to who should be included in these classifications.

At the hearings, which closed July 29, there was general agreement that clear definitions are necessary so that employers can determine what workers come under the act. Attempts to work these out, however, brought forth frequent clashes between representatives of employers, who as a rule proposed broad definitions, and of labor, who fought to keep exemptions down to a minimum. Newspaper publishers, for example, asked for professional status for all workers engaged in the soliciting, writing, and preparation of news and advertising; labor representatives opposed this as an attempt to take the entire industry out from under the law. Several speakers proposed definitions that would make a weekly salary of $25 to $30 the boundary line between non-professional workers and those in the exempted classifications.

Several weeks of study of the testimony presented will precede any attempt to formulate official definitions.

Washington, D.C.
August 6, 1940

Appointments of Society Representatives

WILLIAM G. GROVE, M. Am. Soc. C.E., has been appointed a member of the Structural Steel Committee of the Industrial Research Division of the Welding Research Committee of Engineering Foundation.

J. P. HOGAN, President Am. Soc. C.E., has been appointed one of the Society's representatives on the John Fritz Medal Board of Award to fill the vacancy caused by the expiration of the term of DANIEL W. MEAD, Past-President Am. Soc. C.E.

OTIS E. HOVEY, Hon. M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Board of Trustees of United Engineering Trustees for the four-year term, October 1940 to October 1944.

EUGENE L. MACDONALD, M. Am. Soc. C.E., has been reappointed the Society's representative on the Standards Council of the American Standards Association.

CHARLES E. TROUT, M. Am. Soc. C.E., has been reappointed to represent the Society on the Library Board of the Engineering Societies Library.

News of Local Sections

Scheduled Meetings

COLORADO SECTION—Dinner meeting at the University Club in Denver on September 9, at 6:30 p.m.; meeting of the Junior Association at the City and County Building on September 28, at 8:15 p.m.

DAYTON SECTION—Luncheon meeting at the Dayton Engineers' Club on September 16, at 12:15 p.m.

ILLINOIS SECTION—Meeting of Junior Section at the Y.M.C.A. Hotel on September 9, at 6 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on September 11, at 6:30 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on September 23, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers' Club of San Francisco on September 24, at 5:45 p.m.

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on September 13, at 12 m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Knoxville Sub-Section at the S and W Cafeteria on September 10, at 5:30 p.m.

Recent Activities

INDIANA SECTION—*Lafayette, July 14:* The annual picnic held at Ross Camp, Purdue University, attracted a large attendance. Following the traditional chicken dinner at noon, David E. Ross, chairman of the board of trustees of the university, welcomed the group to the camp and outlined the position of the university in the national defense program. J. E. Hall, president of the Section, then gave a short talk addressed primarily to the student members of his audience who were enrolled at Ross Camp. A series of athletic contests enlivened the remainder of the afternoon, and the swimming pool also proved popular.

MID-MISSOURI SECTION—*Rolla, April 27:* On this occasion members of the Section were entertained at the Missouri School of Mines. Following a dinner President Beckman presented to the Section the United States flag that had been won for the best attendance record at the Kansas City meeting of the Society. Brief talks were then given by the presidents of the Student Chapters at the Missouri School of Mines and the University of Missouri. The technical program consisted of a talk on "Taxes and the Engineer," which was presented by the Hon. Forrest Smith, state treasurer. *July 27:* The summer meeting took the form of a motor-boat trip on the Lake of the Ozarks. During the outing W. S. Frame, of the Union Electric Light and Power Company, described some of the problems encountered in constructing the Grand Glaize Bridge (which extends across an arm of the lake). At the conclusion of the trip the party motored to the dam, where dinner was served. Then Frank I. Baxter, industrial engineer for the Panhandle Eastern Pipe Line Company, showed five reels of colored motion pictures depicting the operations of the company from Oklahoma to Detroit.

TENNESSEE VALLEY SECTION—*Knoxville Sub-Section, July 9:* The feature of the occasion was a talk by Dr. Harcourt A. Morgan, chairman of the board of the Tennessee Valley Authority, who discussed stored and exhaustible energy resources of coal, oil, and gas as compared to current energy resources of water power and plant life. A general discussion followed Dr. Morgan's talk.

ITEMS OF INTEREST

About Engineers and Engineering

CIVIL ENGINEERING for October

OCTOBER 1940 marks the tenth anniversary of CIVIL ENGINEERING. Perhaps this reminder of increasing age was a subconscious influence in selecting next month's papers; at all events, one article on the list is entitled "How Old Are Our Cities?" In it Clarence J. Velz and Henry F. Eich present an interesting study of population prediction, which incidentally can be put to the test as soon as details of the 1940 census become available. The authors remind us that with all signs pointing to a leveling off of population in the not-far-distant future, increasingly careful attention must be given to the estimation of city growth. The methods they propose for predictions are both logical and simple.

Also on the October schedule is an account of the first year's operation of the Richmond-Sunset sewage treatment plant, by B. Benas. This plant, located in Golden Gate Park, San Francisco, handles combined sewage from a tributary population of about 150,000. Treatment processes include chlorination, sedimentation, and sludge digestion, elutriation, and vacuum filtration. Mr. Benas includes descriptions of important features of plant design, but of even more interest are the paragraphs in which he tells how the inevitable "kinks" in operation have been ironed out during the past twelve months.

Structural engineers will particularly welcome Morris Goodkind's second article on the Thomas A. Edison Bridge, in which the construction methods are described in detail. Transportation and erection of steel girder sections that can best be described as "gigantic" were the chief problems on this job and get the major attention in the paper, but the other features of the work are covered as well.

In the field of dam construction there will be two articles dealing with Kingsley Dam, now being built by the Central Nebraska Public Power and Irrigation District. W. J. Turnbull writes of core control in the hydraulic sluicing operations, the problem at Kingsley being the reverse of the usual one where there is an excess of fines in the main borrow pits. George N. Carter's paper describes the construction of the concrete curtain-wall cutoff—a process that involved tunneling into a hillside at the foundation level, pouring the first lift of the wall, and then stoping down the tunnel roof time after time as successive lifts were poured until the curtain reached a height of 100 ft.

Other October papers will cover such fields as hydroelectric plant construction, highway design, waterways development, and reclamation. And, of course, the full program of the Society's Fall Meeting at Cincinnati will also be included.

MEMBERS OF THE SOCIETY GET TOGETHER AT ENGINEER RESERVE OFFICERS CAMP

In Training at Fort Benning, Ga., from July 21 to August 3, Were Twenty Members of the Society. Shown in This Picture Are (Front Row) Maj. J. Lester White, Capt. James E. Goddard, Capt. Bernhard Dornblatt, Lt. Allen Jones, Jr., Lt. James A. Hammack, Capt. Frank E. S. Pou; (Second Row) Lt. Raymond F. Conard, Lt. Col. C. B. Coe, Maj. T. H. Winchester, Lt. Paul M. Blair, and Lt. William A. Darden; (Third Row) Maj. George H. Hudson, Lt. William R. Waugh, Maj. Ralph P. Black, Lt. Donald F. Dougherty, Lt. George A. Heft, and Capt. Henry G. Gerdes. In Camp, but Not in the Picture Were Lt. Col. Kenneth H. Talbot, Capt. J. C. Behrens, and Lt. W. Hiatt.

H. T. Heald Heads Illinois Institute of Technology

ELECTION of Henry T. Heald, thirty-five-year-old Member of the Society, as president of the Illinois Institute of Technology, was announced by that institution following the first meeting of its board of trustees, on July 24. Mr. Heald has for the past two years been president of

HENRY T. HEALD

Armour Institute of Technology, which with Lewis Institute is now merged in the new school.

Union of the two institutes, it is said, "results in the formation of a center of technological education having about 7,000 students in the day and evening classes." During the coming academic year an attempt will be made to coordinate courses, although "there is to be no shakeup of the two faculties." Both campuses are to be used.

Institution of Civil Engineers Maintains Activities on Restricted Scale

"STILL carrying on" is the word from the Institution of Civil Engineers, London. A correspondent in close touch with the Institution writes from the British capital as follows:

"I am glad to say that the Institution has been able to maintain its activities though these necessarily have been restricted in character. Our main object has been to keep the building in Westminster open in order that the Library, etc., may be used, and we have issued the *Journal* as usual though its size of course must depend on paper restrictions. We were able to do some useful work during the past session and I trust that during the coming winter we may again be able to function for the use and service of the members.

"A great deal of work has been done to ensure that members wishing to join the Forces should do so in their technical

capacities, and also that in the change over from peace to war, those working in a civilian capacity should be absorbed into the national effort. Of some 1,300 members and students who have joined the Forces over 90% are either in the Corps of Royal Engineers or in units where their technical training and experience are of value."

Prof. N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

WHILE our Engineers Club customarily passes promptly from dinner to a technical address or discussion, Professor Neare is never at a loss for some excuse to broach a fanciful problem. Like Scheherazade, he starts with an ending and ends with a start.

"Tonight I am delighted that Ken Bridgewater, our Hybrid Engineer, is so busy with his Dunking Bridge that he has resigned to me the pleasure of telling you how many cocoanuts the dictators lost by blitz-selfishness.

"Like so many puzzles, this is a problem in integers. By ordinary algebra, we can let x be the number of cocoanuts gathered by the monkeys for the four dictators, then divide x and successive remainders according to the simple terms of the problem, until each of the climactic 8 equal portions must be:

$$y = \frac{81x - 1{,}441}{5{,}000} = \text{a positive integer} \quad (1)$$

"Trying successively $x = 1, 2, 3, \ldots$, until the numerator becomes a multiple of 5,000, will yield a solution—next week. But write:

$$81x - 1{,}441 - 5{,}000y = 0 \quad (2)$$

$$81(x - 18 - 62y) + 17 + 22y = 0 \quad (3)$$

$$x - 18 - 62y = -\frac{17 + 22y}{81} = z = \text{an integer} \quad (4)$$

"Equation 3 is obtained by separating the numerical coefficients of the second and third terms of Eq. 2 into multiples of the coefficient of the first term, leaving remainders less than half as great; then Eq. 4 follows by numerical division. Introducing the parameter z, Eq. 4 is in the form of Eq. 1. If the simpler fraction can be made an integer for some values of y, those values will satisfy Eq. 1. We could try $y = 1, 2, 3, \ldots$, or repeat the process twice more, viz:

$$y + 4z + 1 = \frac{7z + 5}{22} = w = \text{an integer} \quad (5)$$

$$z - 3w + 1 = \frac{w + 2}{7} = v = \text{an integer} \quad (6)$$

$$w = 7v - 2 \quad (7)$$

"Substituting successively in Eqs. 6, 5, 4, and 2, we find:

$$x = 5{,}000v + 1{,}561 \quad (8)$$

from which, by letting $v = 0, 1, 2, \ldots$, we can obtain an infinite number of solutions of the problem, of which the least—and the only practical one—is 1,561. The next larger, 6,561, is too many cocoanuts for the Brown Dictator to count and divide in a whole night.

"Of course, for those of you familiar with congruences, this algebraic solution will seem quite elementary. For you others who enjoy this type of problem, I recommend a study of congruences and moduli—not hard at all."

"May I interrupt you, Noah?" said our fidgeting Chairman. "There's a long program tonight and no time for your Scheherazade ending—unless 20 seconds will do."

"It will just do! You all know why Ken Bridgewater calls me 'N. G.' But why do I call him a 'Hybrid Engineer'?"

Brief Notes from Here and There

THE American Public Works Association announces its 46th annual conference to be held at the Book-Cadillac Hotel in Detroit on September 30 and October 1 and 2. Problems of works department organization, traffic handling, paving, and sanitation are on the agenda.

* * * *

ESPECIALLY appropriate as a memorial to William Mulholland, late Member of the Society, father of the Los Angeles water supply, is the fountain dedicated in his honor in that city on August 1. It is located on the south side of Los Feliz Boulevard, west of Riverside Drive.

NEWS OF ENGINEERS

Personal Items About Society Members

LLOYD F. RADER has been appointed professor of civil engineering at the University of Wisconsin, his duties to begin in September. Dr. Rader has been a member of the engineering faculty at the Polytechnic Institute of Brooklyn for the past twelve years.

JAMES M. SPEARMAN, formerly in the U.S. Engineer Office at Pittsburgh, Pa., has accepted an appointment as junior hydraulic engineer for the U.S. Geological Survey and is stationed at Helena, Mont.

A. J. COOPER is now living in Jacksonville, Fla., where he has been placed in charge of Robert and Company's new office. Until recently Mr. Cooper was manager of the structural department of the organization at Atlanta, Ga.

JAMES H. LEVAN, who is on the staff of the U.S. Public Health Service, has been transferred from the U.S. Quarantine Station at Brownsville, Tex., to the National Institute of Health at Bethesda, Md., where he will be on duty in the laboratory.

N. W. DOUGHERTY, professor of civil engineering at the University of Tennessee, has been named dean of the engineering college. Professor Dougherty has been a member of the engineering faculty there since 1916.

HARRY H. CHENOWETH, previously with the U.S. Bureau of Reclamation at Coulee Dam, Wash., has taken a position as engineering aide in the U.S. Engineer Office at Portland, Ore.

ARTHUR C. EVERHAM, senior partner in the Everham Foundation Company, Kansas City, Mo., has been appointed to the post of director of public works of Kansas City. Another member of the Society—KENNETH K. KING—has been appointed director of the water department. At one time Mr. King was in charge of a large part of the construction of Kansas City's water works.

ARTHUR F. PERRY, JR., has accepted active duty in the U.S. Navy with the rank of lieutenant commander. He has been assigned to work on the Southeastern naval air base project in Duval, Brevard, and Dade counties, Florida. Mr. Perry has been a reserve officer in the Civil Engineer Corps of the U.S. Navy.

S. O. HARPER, assistant chief engineer of the U. S. Bureau of Reclamation at Denver, Colo., has been designated chief engineer to take over the duties of the late RAYMOND F. WALTER.

EDWARD D. RICH, since 1913 director of the bureau of engineering of the Michigan Department of Health, has retired from that position but will continue as assistant engineer with the bureau.

ROBERT C. DEHART is now field inspector with the Standard Oil Company of Indiana.

DANIEL NOCE was recently promoted from the rank of major to that of lieutenant colonel. Colonel Noce is district engineer for the Memphis district of the U.S. Engineer Office.

F. L. ENDEBROCK, formerly associate civil engineer for the Tennessee Valley Authority on the construction of Hiwassee Dam, has been called to active duty as a lieutenant (jg) in the Civil Engineer Corps of the U.S. Naval Reserve and is now located at the Public Works Office of the Sixth Naval District at Charleston, S.C.

CHARLES L. BURY is at present chief draftsman for the Seismograph Service Corporation, of Tulsa, Okla. Until lately he was industrial safety engineer for T. H. Mastin and Company, of High Point, N.C.

DAVID MUIR MACALPINE, during the past year a member of the civil engineering faculty at Robert College, Istanbul, Turkey, has returned to the United States to resume his position as instructor in civil engineering at the College of the City of New York.

C. C. OLESON has accepted a position as assistant professor of civil engineering at South Dakota State College. He was formerly on the staff of the Pennsylvania Turnpike Commission at Somerset, Pa.

LYMAN W. TONDRO, first lieutenant, Ordnance Reserve, is now at the Ordnance School of the U.S. War Department, Aberdeen Proving Ground, Md.

ALBION N. VAN VLECK, consulting engineer of New York City, has been des-

ignated consulting engineer for the Mortgage Conference of New York. Major Van Vleck's work will consist of the inspection and structural rating of buildings under construction in the city.

G. H. BURNETTE recently became president of the Cambria and Indiana Railroad, with headquarters in Philadelphia, Pa. Until recently Mr. Burnette was assistant chief engineer of the Pittsburgh and Lake Erie Railroad Company at Pittsburgh, Pa.

ALEXANDER EPSTEIN is now assistant state director of the U.S. Public Health Service, and is located at Columbia, S.C.

DOUGLAS A. NETTLETON, for the past year on the staff of the Phelps Dodge Corporation, has been appointed a member of the faculty of Cooper Union in New York City.

DOUGLAS B. FUGATE, resident engineer for the Virginia State Department of Highways, has been transferred from Franklin, Va., to Sandston.

JOSEPH W. BARKER and ERNEST L. ROBINSON have been added to the list of Society members awarded honorary degrees during the past commencement season. Professor Barker received the honorary degree of doctor of laws from Bucknell University, and Mr. Robinson, the honorary degree of doctor of science from St. Lawrence University. Other members of the Society thus honored were listed in the July and August issues of CIVIL ENGINEERING.

G. E. EDGERTON, colonel, Corps of Engineers, U.S. Army, has been appointed governor of the Panama Canal. Governor Edgerton was formerly engineer of maintenance at the Canal.

CHARLES R. PODAS is now with the firm of Ralph D. Thomas and Associates, consulting engineers of Minneapolis, Minn.

GEORGE J. NOLD, major, Corps of Engineers, U.S. Army, is now with the 28th Engineers at Ketchikan, Alaska. Major Nold was previously district engineer in the U.S. Engineer Office at Binghamton, N.Y.

DONALD D. PRICE has resigned as technical engineer for the Ash Grove Lime and Portland Cement Company, of Omaha, Nebr., to join the Builders Service, Inc., at North Platte, Nebr.

J. W. HUBLER, formerly instructor in agricultural engineering at Purdue University, has accepted a position as assistant professor of civil engineering at Alabama Polytechnic Institute.

DECEASED

THOMAS WILEY CLAYTON (M.' 07) since 1921 city engineer of Dixon, Ill., died on June 13, 1940. He was 68. Early in his career Mr. Clayton was engaged in railroad and elevated railroad work in Chicago, having been with the Chicago and Alton Railway, the South Side Elevated Railroad, the Chicago and Northwestern Railway, and the Chicago Rapid Transit Company. During the war he served with the Corps of Engineers, U.S. Army, in France, having the rank of captain.

ROBERT PAUL DURHAM (M. '17) for a number of years president of the Macdonald Engineering Company, Chicago, Ill., died in that city on July 7, 1940. Mr. Durham, who was 60, had built grain elevators in many parts of the world and, at one time, was in charge of the construction of a $100,000,000 system of industrial plants in the Soviet Union.

WILLIAM LEONARD GLAZIER (M. '07) civil and consulting engineer of Cincinnati, Ohio, died in that city on July 28, 1940. Mr. Glazier, who was 73, had been in private practice with the firm of Glazier and Morlidge since 1919. Before that he served as a major in the Corps of Engineers in this country and France, and from 1896 to 1911 he was connected with the Newport, Ky., department of public works—for some years in the capacity of city engineer.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

FRANK HOLMES (Assoc. M. '08) retired construction engineer of Chicago, died in Evanston, Ill., on July 10, 1940, at the age of 68. Mr. Holmes supervised work on permanent buildings during the construction of the Panama Canal. He was also in charge of the construction of a number of notable structures, including the Woolworth Building in New York. From 1933 until his retirement in 1938 Mr. Holmes was vice-president and director of research for H. M. Preston and Company, of Chicago.

ARTHUR NEWHALL JOHNSON (M. '09) dean emeritus of the college of engineering at the University of Maryland, died in Baltimore, Md., on July 11, 1940, at the age of 69. Recognized as a pioneer in hard-surface highway construction, Dr. Johnson became dean at the University of Maryland in 1920 and retired in 1936. Prior to that he had been state highway engineer of Maryland (1898 to 1905); state highway engineer of Illinois (1906 to 1914); and consulting highway engineer for the Portland Cement Association (1916 to 1920).

CHARLES FILLMORE MEBUS (M. '06) municipal and sanitary engineer of Glenside, Pa., died recently at the age of 75. From 1893 to 1904 Mr. Mebus was with Chester E. Albright, civil engineer of Philadelphia, and from 1904 to 1931 a member of the Philadelphia firm of Albright and Mebus. Since the latter year he had been in private practice at Glenside.

EDWARD MENZEL NOON (Assoc. M. '31) civil engineer for the Martin Engineering Company of Maracaibo, Venezuela, died there recently at the age of 39. Mr. Noon's experience included work with the Arizona State Highway Department and the Los Angeles County (California) Department of Surveying. Later he was in charge of construction work for the Standard Fruit and Steamship Company in Honduras and, for several years, was engineer for C. O. Tappan, of New York City.

THEODOR SMIDT OXHOLM (M. '97) retired consulting engineer of West New Brighton, N.Y., died in that city on July 1, 1940. He was 73. Mr. Oxholm was for many years engineer in charge of the Bureau of Engineering, Borough of Richmond, and from 1923 to 1933 was consulting engineer for the Borough. In the latter year he retired.

MARTIN P. PETERSON (Assoc. M. '30) of Paris, France, was killed in an automobile accident at Lyons, France, on January 27, 1940. He was 47. Born in Riga, Latvia, Mr. Peterson worked in both Latvia and Russia before coming to this country where (1918 to 1925) he was with Charles E. Clark, builder of Philadelphia, Pa. From 1926 to 1928 he was superintendent of construction for the American University at Cairo, Egypt, and later was construction engineer for the Socony-Vacuum Oil Company at Cairo.

JOSEPH HENRY PRIOR (M. '14) chief architectural engineer for the Chicago Board of Education, died at his home in that city on July 1, 1940. From 1897 to 1902 and from 1904 to 1914 Mr. Prior was with the Milwaukee, St. Paul and Pacific Railroad Company, serving successively as draftsman, assistant engineer, and engineer of design. In 1914 he became chief engineer of the State Public Utilities Commission of Illinois (now the Illinois Commerce Commission) and, later, maintained a consulting practice in Chicago.

WILLIAM EDWARD ROLFE (M. '15) of St. Louis, Mo., died in that city on July 15, 1940, at the age of 66. Mr. Rolfe entered the employ of the city of St. Louis in 1895 and remained there until 1933, having been assistant to the president of the Board of Public Service for the last twenty years of this period. From 1938 on he was connected with L. Roy Bowen and Associates.

ALVAH HORTON SABIN (Assoc. M. '96) died in New York City on July 11, 1940, at the age of 89. From 1888 to 1905 Mr. Sabin was chemical engineer for Edward Smith and Company, of New York; from 1906 to 1910 he maintained a consulting office in New York; and from 1910 until his retirement in 1937 he was consulting chemist for the National Lead Company, of New York. For many years, also, Mr. Sabin lectured at New York University, and he was the author of numerous volumes on paint and varnish.

WILLIAM ORSEN VAN GIESEN (Assoc. M. '39) captain, Corps of Engineers, U.S. Army, died at Walter Reed Hospital in Washington, D.C., on June 3, 1940. Cap-

tain Van Giesen, who was 40, had been with the army since 1926. He had had the rank of captain since 1936 and, until recently, was assistant district engineer in the U.S. Engineer Office at Binghamton, N.Y.

CLAUDE ALLEN WEBB (Assoc. M. '20) of Chicago, Ill., died on August 4, 1940, of injuries received in a motor accident near Madison, Wis. He was 52. During the war Mr. Webb served with the A.E.F. in France. From 1919 until 1930 he was salesman and field engineer for the Universal Portland Cement Company in Chicago, and from the latter year until 1939 was with the Universal Atlas Cement Company—first as district sales manager and, later, as sales manager.

CHARLES EDWIN WELLS (M. '92) consulting engineer of North Adams, Mass., died at his home there on August 4, 1940, at the age of 82. At one time Mr. Wells was division engineer for the New York City Board of Water Supply, being in charge of the construction of the Hillview section of the Catskill Aqueduct at Yonkers, N.Y. He had also served with the Metropolitan Water Board of Boston, and with the U.S. Bureau of Reclamation in Wyoming, Nebraska, and South Dakota.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From July 10 to August 9, 1940, Inclusive

ADDITIONS TO MEMBERSHIP

AMIDON, ROGER EDMUND (Assoc. M. '40), With U.S. Forest Service, 158 North Michigan Ave. (Res., 624½ North Vermont Ave.), Glendora, Calif.

ANDERSSON, KINGSLEY SHERMAN (M '40), Capt., Corps of Engrs., U.S. Army, Acting Dist. Engr., U.S. Lake Survey, Room 649 Federal Bldg., Detroit (Res., 1245 Fair Oaks Parkway, Ann Arbor), Mich.

ASLAKSON, CARL INGMAN (M. '40), Lt., U.S. Coast and Geodetic Survey, Washington, D.C.

BENSON, RUPERT ARTHUR (Assoc. M. '40), Res. Engr., Pennsylvania Turnpike Comm., 11 North 4th St., Harrisburg (Res., 307 North 24th St., Camp Hill), Pa.

BOWER, WILLIAM EDWARD (Jun. '40), Estimator, Midwest Steel & Iron Works Co., 25 Larimer (Res., 786 Columbine St.), Denver, Colo.

BROWN, ROGER CHIPMAN (Assoc. M. '40), Asst. Engr., Clarence M. Blair, Inc., 100 Crown St., New Haven (Res., 41 Elm St., East Haven), Conn.

CAMPBELL, WILLIAM WARD (Jun. '40), Constr. Engr., The Warren Eng. Co., 402 Atlantic St., Warren (Res., 327 East Liberty St., Girard), Ohio.

CATES, VINCENT KACZYNSKI (Assoc. M. '40), Technical Service Engr., Universal Atlas Cement Co., Chrysler Bldg., New York, N.Y. (Res., 69 Burrell St., Melrose, Mass.)

CRAWSHAW, HARRIS VERNON (Assoc. M. '40), Asst. Engr., Met. Water Dist. of Southern California, 306 West 3d St., Los Angeles (Res., 12015 Hesby St., North Hollywood), Calif.

CREED, JOHN HEDLEY (Assoc. M. '40), Asst. Highway Engr., State Div. of Highways, North State, Ukiah, Calif.

DANIELS, GEORGE ALBERT (Jun. '40), Care, Shell Petroleum Co., Shell Point, Pittsburg, Calif.

DAVIES, ARVON LLOYD (Jun. '40), Instr., College of Eng., Univ. of Michigan, 1224 East Eng. Bldg., Ann Arbor, Mich.

DILLENBECK, RONALD BATES (Assoc. M. '40), Asst. Constr. Engr., Madigan-Hyland, 2804 Forty-First Ave., Long Island City (Res., 32 Westminster Rd., Rockville Centre), N.Y.

DOLL, THEODORE FRANCIS (M. '40), Engr., Standard Oil Co. (Indiana), 1915 Front St., Whiting, Ind. (Res., 419 Surrey Lane, Crete, Ill.)

DOOLITTLE, EDWARD JENKINS, JR. (Jun. '40), Engr., La Luz Mines Ltd., Siuna, Nicaragua.

EMERY, JAMES ALBERT, JR. (Jun '40), Asst. to Eng. Secy., Am. Transit Assoc., 292 Madison Ave., New York, N.Y.

GOULD, EDWARD CAUVET (Assoc. M. '40), 4912 York Ave., South, Minneapolis, Minn.

HITEMAN, LESLIE HENRY (Jun. '40), R. R. 6, Box 438, Cincinnati, Ohio.

ILLINGWORTH, LELAND RUSSELL (Jun. '40), Junior Engr., Shell Chemical Co., Shell Point, Pittsburg, Calif.

JENNER, LESLIE CHARLES (Jun. '40), Structural Draftsman, Am. Bridge Co., Ambridge (Res., 319 Elizabeth St., Sewickley), Pa.

KEELOR, DON PIATT (M. '40), Senior Engr., U.S. Engrs., New Federal Bldg. (Res., 7029 Church Ave., Ben Avon), Pittsburgh, Pa.

LAWRENCE, RAY GOODMAN (Jun. '40), Job Engr., Fluor Corp., Ltd., Edgerton, Ind. (Res., Smith Center, Kans.)

LOGAN, ROY (Assoc. M. '40), Associate Engr., U.S. Engrs., War Dept., 332 Post Office Bldg., Baltimore, Md.

MACKALL, MURRAY RANDOLPH (M. '40), Hydr. Engr., California R.R. Comm., State Bldg., San Francisco, Calif.

MCFARLAND, WILBURN JAYE, JR. (Jun. '40), Care, Dept. of Civ. Eng., Michigan State College, East Lansing, Mich.

MAYO, ROBERT SPRAGUE (M '40), 532 Race St., Lancaster, Pa.

MENDELSON, SHELDON HAROLD (Jun. '40), Company B, 31st U.S. Infantry, Manila, Philippine Islands.

MUELLER, RALPH WILLIAM (Jun. '40), Junior Engr., U.S. Engrs., U.S. Engr. Office, Mobile, Ala.

NICOLI, FRANK ANTHONY (Jun. '40), Asst. Engr., Metcalf & Eddy, 1300 Statler Bldg., Boston (Res., 56 Howard St., Springfield), Mass.

NIKIRK, FRANK AUSTIN (M. '40), Civ. Engr., Caterpillar Tractor Co. (Res., Hotel Pere Marquette), Peoria, Ill.

PASSALACQUA SANTIAGO, CARLOS MANUEL (Assoc. M. '40), 16 Ruiz Belvis St., Coamo, Puerto Rico.

PETERSON, BURDETTE ERNEST (Jun. '40), Junior Topographic Engr., U.S. Geological Survey, North Interior Bldg., Washington, D.C.

PETERSON, PAUL GILBERT (Assoc. M. '40), Structural Engr., Bethlehem Steel Co., Wrigley Bldg. (Res., 1624 Olive Ave.), Chicago, Ill.

PNEUMAN, FRED ASHLEY (M. '40), Structural Steel Designer, Am. Bridge Co., 208 South La Salle St., Chicago, Ill.

PRATELY, PHILIP LOUIS (M. '40), Cons. Engr., 1117 St. Catherine St., West, Montreal, Canada.

RAGAINI, FRANK (Assoc. M. '40), Civ. Engr., Clarence M. Blair, Inc., 100 Crown St., New Haven (Res., 547 Savin Ave., West Haven), Conn.

REYBOLD, EUGENE (M. '40), Col., Corps of Engrs., U.S. Army, Gen. Staff Corps, Munitions Bldg., Washington, D.C.

RICKER, CONNY CLYDE (M. '40), Dist. Engr., SCS, Court House (Res., 1012 South East 2d St.), Evansville, Ind.

ROBINSON, WILLIAM HAROLD (Jun. '40), Junior Engr., Seattle Transit System, City Engrs. Office (Res., 3054 Railroad Ave., N.E.), Seattle, Wash.

ROSEN, ISIDORE SAM (Jun. '40), Junior Engr. (Civ.), U.S. Engrs., Room 403 Chamber of Commerce Bldg. (Res., 751 Chislett St.), Pittsburgh, Pa.

ROSS, HAMILTON MURRAY, JR. (Jun. '40), With Bethlehem Steel Co., Pottstown, Pa. (Res., 150 Union Ave., Clifton, N.J.)

SERAT, GEORGE WILLIAM (M. '40), Designing Engr., Am. Bridge Co., 208 South La Salle St., Chicago, Ill.

SMITH, ROBERT WAKEFIELD (Jun. '40), Asst. Area Engr., SCS, Box 1001, Santa Paula, Calif.

SPHAR, LELAND LAWRENCE (Jun. '40), Junior Engr., U.S. Geological Survey, Ohio State Univ. (Res., 337 Thirteenth Ave.), Columbus, Ohio.

SWANSON, LLOYD HAROLD (Jun. '40), Civ. Engr., E. H. Dunmire, 2774 South St. (Res., 301 South 18th), Lincoln, Nebr.

THORPE, FREDERICK THOMAS, JR. (M. '40), Surveyor and Regulator, 2d Dist., Bureau of Eng. Surveys and Zoning, 1327 South 12th St. (Res., 1129 Sanger St.), Philadelphia, Pa.

TUETING, WILLIAM FRANCIS (Jun. '40), Eng. Aide, Civ., U.S. Engrs., St. Paul Dist., U.S. Engr. Field Office, Wheaton, Minn.

VICTOR, FRED SAMUEL, JR. (Jun. '40), Care, Phillips Petroleum Co., Gen. Motors Bldg., Detroit, Mich.

WATTERS, PAUL WALTER (Jun. '40), With Traffic and Safety Dept., State Highway Comm. (Res., 108 Beach Ave.), Ames, Iowa.

WELLS-JONES, ARTHUR JOHN (M. '40), Cons. Engr., 609 Union House, Queen Victoria St., Cape Town (Res., "Arcadia," Portland Rd. Rondebosch), Union of South Africa.

WILLETT, CHARLES KENNETH (Assoc. M. '40), Cons. Engr., City National Bank Bldg., Dixon, Ill.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1940	
Members	5,673
Associate Members	6,516
Corporate Members	12,189
Honorary Members	31
Juniors	4,233
Affiliates	71
Fellows	1
Total	16,525

MEMBERSHIP TRANSFERS

APPLEGATE, DANIEL WEBSTER (Jun. '33; Assoc. M. '40), Asst. Engr., U.S. Bureau of Reclamation, Box 102, Ontario, Ore.

BENNETT, EARL ROBERT (Jun. '31; Assoc. M. '40), Lt. (jg), C.E.C., U.S. Naval Reserve, Asst. to Public Works Officer, Naval Submarine Base, New London, Conn.

BERRY, DAVID MAURICE (Jun. '36; Assoc. M. '40), Junior Bridge Engr., State Div. of Highways, Bridge Dept., Box 1499, Sacramento (Res., 121-C St., Davis), Calif.

BEST, WALTER EUGENE (Jun. '37; Assoc. M. '40), Associate Engr., U.S. Engr. Office, Vicksburg, Miss.

BOLLMAN, LESLIE WEBER (Jun. '34; Assoc. M. '40), Line and Grade Engr., Board of Water Supply, City of New York, Lackawack (Res., Honk Hill, Napanoch), N.Y.

BUCK, HENRY WOLCOTT (Jun. '25; Assoc. M. '34; M. '40), (Buck & Buck), 650 Main St., Hartford, Conn.

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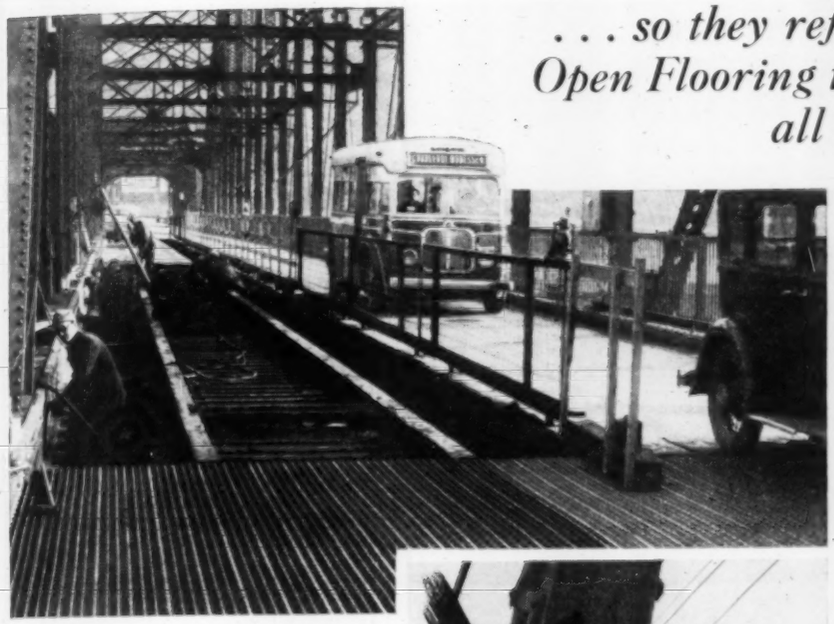
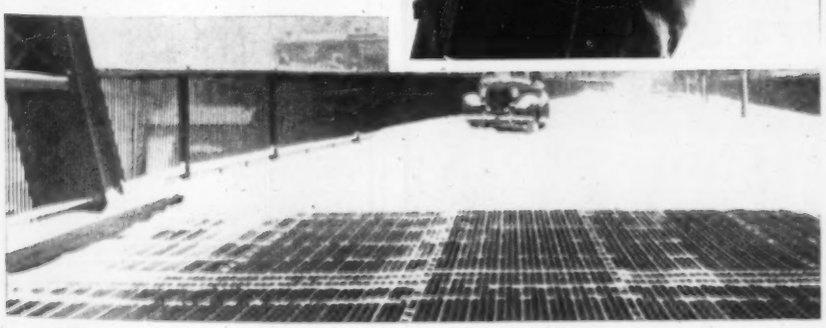


TRAFFIC KEEPS FLOWING AS NEW FLOOR GOES DOWN. Take a tip from this toll bridge job. Crossing the Monongahela River at North Charleroi, Pa., this bridge floor required frequent and expensive maintenance. When replacement was necessary, the owners, The Mercantile Bridge Company, insisted on getting a new floor that would stand up . . . that would go down with least disturbance of traffic . . . and that would pay for itself in long service and low maintenance. They chose U·S·S I-Beam-Lok Open Flooring.

NO MORE NEED FOR THIS SIGN. The treaded surface of I-Beam-Lok Open Flooring makes driving safe, *always*. In skid tests, after ice had formed, a car driven at 35 m.p.h. came to a perfect stop when brakes were suddenly applied, only a slight skid forward in a straight line occurred—no side skid whatever.



HERE in a privately operated toll bridge, where every dollar invested for construction and upkeep must justify itself, the economic and structural advantages of U·S·S I-Beam-Lok Open Flooring are brought into sharp focus.

These money-saving and time-saving advantages include:

1. Light Weight. U·S·S I-Beam-Lok Open Floor weighs only 18.6 lbs. per sq. ft. The old floor on this bridge weighed approximately 49 lbs. per sq. ft., had a posted permissible capacity of 12 tons per vehicle. To reinforce the structure, 8" I-Beam purlins on 4' centers were laid on longitudinal stringers. Even with the purlins, the new open floor now weighs only 24 lbs. per sq. ft.—less than half the old construction, now has capacity for 20-ton vehicles.

2. Rapid Installation. I-Beam-Lok Open Flooring comes in large pre-fabricated units, 6' 2" wide, up to 49' long. On this bridge, units 32' long were used. Weighing less than 2500 lbs. each, they were easily handled by 5 men. Eighteen men completed the entire floor, 1000 ft. long, 22 ft. wide, in less than 75 working days.

3. Self Cleaning. Snow, dirt and dust simply fall through the large $1\frac{5}{8}$" x $2\frac{3}{4}$" rectangular openings. In last winter's heaviest snow fall (see photograph lower left) while adjacent river crossings were snow blocked, this I-Beam-Lok Open Floor was clear of snow, doing business as usual. The snow covered approach section is now being replaced with I-Beam-Lok Open Flooring.

4. Fireproof. All-steel construction absolutely eliminates fire hazards.

5. Low Cost Maintenance. Made of superior corrosion resisting U·S·S Copper Steel, no section less than $\frac{1}{4}$" thick, this floor will last as long as the bridge. The only maintenance required is occasional cleaning and painting, easily done from the decking surface.

Our engineers will gladly discuss the economies and application of this truly modern bridge floor with you.

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UNITED STATES STEEL

BUCK, ROBINSON DUDLEY (Jun. '31; Assoc. M. '40), (Buck & Buck), 650 Main St., Hartford, Conn.

CANTONO, WILLIAM PAUL (Jun. '31; Assoc. M. '40), Asst. Engr., Board of Water Supply, City of New York, 346 Broadway (Res., 4364 Richardson Ave.), New York, N.Y.

COOK, ROBERT (Jun. '28; Assoc. M. '40), Supt. of Constr., National Excavation Corp., 10 East 40th St. (Res., 1945 Loring Pl.), New York, N.Y.

CULLIMORE, WILLIAM HENRY HARRISON, 3d (Assoc. M. '27; M. '40), Engr.-Secy., National Paving Brick Assoc., 1245 National Press Bldg., Washington, D.C.

DAVIDSON, FREDERIC ARMSTRONG (Assoc. M. '20; M. '40), Engr., Coverdale & Colpitts, 120 Wall St., New York (Res., 9 Keogh Lane, New Rochelle), N.Y.

DOHRENWEND, CLAYTON OLIVER (Jun. '31; Assoc. M. '40), Asst. Prof. of Civ. Eng., Univ. of Connecticut, Storrs, Conn.

FINCK, GEORGE EDWARD (Assoc. M. '20; M. '40), Sewerage Engr., Head, Bureau of Sewers, City of Baltimore, 312 Municipal Bldg. (Res., 4306 Ethland Ave.), Baltimore, Md.

GEBHARDT, JOHN FREDERICK WILLIAM (Jun. '13; Assoc. M. '16; M. '40), With Stone & Webster Eng. Corp., Rankin, Pa.

GIDLOW, WILLIAM (Jun. '30; Assoc. M. '40), Engr., McLain Const. Corp. (Res., 419 Tenth St.), Niagara Falls, N.Y.

GROSS, MICHAEL ALBERT (Jun. '30; Assoc. M. '40), Eng. Draftsman, P. & L.E.R.R., Room 500, P.&L.E. Terminal Bldg. (Res., 5836 Maeburn Rd., Squirrel Hill Station), Pittsburgh, (17), Pa.

HALE, JOHN FLOTRON (Assoc. M. '24; M. '40), Chf. Engr., City Engr's. Office, 701 U. B. Annex (Res., 216 Fountain Ave.), Dayton, Ohio.

LUNDQUIST, EUGENE EDWARD (Jun. '28; Assoc. M. '40), Aeronautical Engr., National Advisory Committee for Aeronautics, Langley Field, Va.

MCGILVRA, ROBERT DICKINSON (Jun. '33; Assoc. M. '40), Res. Engr., Ash-Howard-Needles & Tammen, 55 Liberty St., New York, N.Y.

MILLER, ORRIS JOSEPH (Assoc. M. '21; M. '40), Asst. Superv. Engr., The Commonwealth & Southern Corp., 212 West Michigan Ave., West (Res., 774 Crescent Rd.), Jackson, Mich.

RANKIN, ARDERY ROBERT (Jun. '31; Assoc. M. '40), Asst. Highway Engr., U.S. Public Roads Administration (Res., 613 Aspen St., N.W.), Washington, D.C.

REES, HAROLD (Jun. '34; Assoc. M. '40), Office Engr., Research and Mechanical Standards, Union Pacific R.R., 1416 Dodge (Res., 2520 Read St.), Omaha, Nebr.

ROACH, ALDEN GALLUP (Jun. '24; Assoc. M. '28; M. '40), Executive Vice-Pres., Consolidated Steel Corp., Ltd., 5700 South Eastern Ave., Los Angeles, Calif.

SAWYER, ALFRED WORCESTER (Jun. '37; Assoc. M. '40), Asst. Engr., Malcolm Pirnie, 25 West 43d St., New York, N.Y.

VENARD, JOHN VICTOR (Jun. '35; Assoc. M. '40), Asst. Engr., Grade A, State Highway Comm., Ulysses, Kans.

WIESENBERG, WILLIAM MAURICE (Assoc. M. '20; M. '40), Engr.-Examiner, PWA, 2 Lafayette St. (Res., 59 St. Marks Pl.), New York, N.Y.

WILLIAMS, WYATT EDWIN (Jun. '31; Assoc. M. '40), Asst. Engr., The Solvay Process Co., Hopewell (Res., Walnut Hill Apartments, Apt. J-4, Petersburg), Va.

YANDA, ALFRED DANIEL (Jun. '32; Assoc. M. '40), Senior Asst. Civ. Engr., Cuyahoga County Engr's. Office, 1920 Standard Bldg. (Res., 12310 Miles Ave.), Cleveland, Ohio.

REINSTATEMENTS

BARTE, GEORGE RUSSELL, Assoc. M., reinstated Aug. 6, 1940.

BARTON, HARRY, Assoc. M., reinstated July 16, 1940.

FOSS, FREDERIC DEARBORN, M., reinstated July 15, 1940.

ROWE, EDGAR ALAN, Assoc. M., reinstated Aug. 5, 1940.

SCUDDER, HENRY DARCY, JR., Assoc. M., reinstated July 15, 1940.

RESIGNATIONS

DAWLEY, WALTER MANVILLE, M., resigned July 18, 1940.

GALLIGAN, WILLIAM BARTHOLOMEW, Jun., resigned Aug. 7, 1940.

GRIDLEY, CHARLES ALBERT, Assoc. M., resigned July 10, 1940.

HALL, MELVILLE COOPER, Assoc. M., resigned June 28, 1940.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

September 1, 1940 NUMBER 9

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ABDUN-NUR, EDWARD AMIN (Assoc. M.), Billings, Mont. (Age 37) (Claims RCA 1.8 RCM 5.7) Feb. 1938 to Oct. 1939 Asst. Engr., and Oct. 1939 to date Associate Engr., U.S. Dept. of Interior, CCC-Indian Div.; previously Soil Technician, Board of Water Commrs., Denver, Colo.

ASCARELLI, MARIO, New York City. (Age 43) (Claims RCM 17.6) March 1940 to date Railroad Products Engr., U.S. Steel Export Co. (subsidiary of U.S. Steel Corporation); previously Head and Director of Municipal Tramways and Autobuses Co. of Rome, Italy.

BAIN, JARVIS JOHNSON, Richmond, Va. (Age 60) (Claims RCA 2.5 RCM 24.1) Sept. 1905 to date with Corps of Engrs., U.S. Army as Co. and Bn. Officer, Asst. to U.S. Dist. Engr., U.S. Dist. Engr., Lt. Col., Col., Chf. Engr., Eng. Instructor, Commanding Officer, and (since May 1938) Div. Engr., South Atlantic Div., U.S. Eng. Dept.

CAMPBELL, FRANK BIXBY (Assoc. M.), Denison, Tex. (Age 35) (Claims RCA 0.5 RCM 6.5) Nov. 1938 to date Associate Engr., and Head of Hydr. Sec., U.S. Engr. Office; Dec. 1935 to Oct. 1938 Associate Soil Conservationist, U.S. SCS; previously Engr., Board of Water Commrs., Denver, Colo.; Asst. Engr., Platte Valley Public Power & Irrigation Dist., North Platte, Nebr.

DOWNES, WILLIAM EDWARD, JR., Chicago, Ill. (Age 35) (Claims RCA 0.4 RCM 11.8) Jan. 1927 to date with City of Chicago, until July 1932 with Board of Local Improvements as Rodman, Jun. Engr., and Asst. Engr., and (since July 1932) with Bureau of Eng. as Asst. Engr.

DWYRE, BURTON GOLDING (Assoc. M.), Santa Fe, N.Mex. (Age 39) (Claims RCA 11.5 RCM 5.6) Dec. 1920 to July 1925 and Jan. 1935 to date with New Mexico State Highway Dept., as Instrumentman, Project Engr., Asst. State Highway Engr. and (since Jan. 1939) State Highway Engr.

GOLDENBERG, CHARLES NORDHAUS, Santa Fe, N.Mex. (Age 42) (Claims RC 10.2 D 5.0) May 1938 to date in private practice; previously Engr. Inspector and Office Engr., PWA.

GUNDRUM, NORMAN HENRY, Springfield, Ill. (Age 43) (Claims RCA 4.6 RCM 15.9) Aug. 1920 to date with Illinois Div. of Highways as Jun. Highway Engr. and (since April 1923) Asst. Highway Engr.

JONES, RALPH WESLEY (Assoc. M.), Philadelphia, Pa. (Age 43) (Claims RCA 4.2 RCM 18.1) April 1933 to date in private practice.

KUNZE, ALBERT TENANT, Wyandotte, Mich. (Age 43) (Claims RCA 4.2 RCM 15.3) Oct. 1939 to date Supt., Wayne County sewage-disposal system; previously Designing Engr., Board of Wayne County Road Commrs.; member of firm, Hayden and Kunze, in general practice of municipal engineering.

MCCREARY, ADRIEL RAYMOND, Cleveland Heights, Ohio. (Age 54) (Claims RCA 5.5 RCM 17.0) 1937 to date Gen. Mgr. with Harry A. Fulton, Archt., Cleveland, Ohio; 1930 to 1937 various unimportant positions.

MASON, FAGAN BARB (Assoc. M.), Corpus Christi, Tex. (Age 42) (Claims RCA 4.5 RCM 12.2) Aug. 1925 to date with Texas State Highway Dept., as Office Engr., Asst. Res. Engr., Res. Engr., and (at present) Senior Res. Engr.

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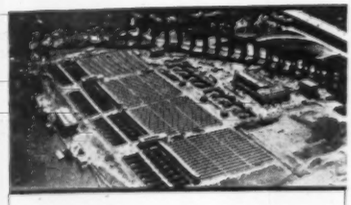

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WORTHINGTON

MORGAN, GEORGE, Detroit, Mich. (Age 46) (Claims RCA-0-8 RCM 15.7) Dec. 1937 to Jan. 1940 Res. Engr., Giffels & Vallet, Detroit; previously Senior Cons. Engr., Constr. Dept., People's Commissariat of Railroads, U.S.S.R., and with Moscow Subway Constr. Trust.

NORTON, JOHN KENNEDY, Detroit, Mich. (Age 46) (Claims RCA 3.0 RCM 20.0) 1920 to date Road Engr., Wayne County Road Comm.

SAWYER, WILLIAM LINCOLN (Assoc. M.), Gainesville, Fla. (Age 35) (Claims RC 10.8 D 0.9) Oct. 1929 to date with Coll of Eng., Univ. of Fla., as Instructor, Asst. Prof., and (since April 1939) Associate Prof. of Civ. Eng.

STANDLEY, DAVID (Assoc. M.) Brooklyn, N.Y. (Age 41) (Claims RCA 6.7 RCM 10.5) Feb. 1934 to date with WPA as Superv. Engr.; Project Mgr., etc., and (since June 1938) Director and (later) Mgr., Manhattan Dist. Office.

STANLEY, CLAUDE MAXWELL, JR. (Assoc. M.), Muscatine, Iowa. (Age 36) (Claims RCA 2.0 RCM 10.5) Feb. 1932 to date member of firm, Young & Stanley, Inc., and (since June 1939) Stanley Eng. Co. (successor).

WASHBURN, WALTER WEBSTER, Houston, Tex. (Age 54) (Claims RCA 10.5 RCM 16.5) March 1925 to June 1928 and Jan. 1940 to date Chf. Engr., Southwestern Constr. Co.; in the interim Engr.-Inspector, PWA; Field Engr., Rice Irrigation Canal Construction Sandy Point, Tex.; with Texas State Highway Dept.; with Ernest A. Podd Co., Houston.

WAXMAN, DAVID, Clayton, Mo. (Age 42) (Claims RCA 8.8 RCM 12.3) May 1929 to date Mgr., Asphalt Sales Dept., Shell Petroleum Corporation (Shell Oil Co., Inc.).

APPLYING FOR ASSOCIATE MEMBER

ADDINGTON, MARTIN RATLIFF, Pittsburgh, Pa. (Age 37) (Claims RCA 4.7) Nov. 1930 to Aug. 1933, Jan. 1934 to May 1938 and July 1938 to date with U.S. Engr. Office as Instrumentman and (since April 1931) Surveyman; in the interim Project Engr., Pennsylvania Dept. of Highways, Franklin, Pa.; Chf. of Party, TVA.

BERNAT, HARRY JACOB, Corpus Christi, Tex. (Age 31) (Claims RCA 3.4) July 1940 to date Asst. Supt. Marine Constr., Naval Air Base, Corpus Christi, Tex.; April to July 1940 Constr. Engr., Massman Constr. Co. at Beaumont, Tex.; Oct. 1938 to March 1940 Res. Engr., Ash, Howard, Needles & Tammen, Cons. Bridge Engrs.; Nov. 1936 to Sept. 1938 Constr. Engr., Kansas City Bridge Co.

BROWNE, FREDERICK LEE (Junior), Honolulu, Hawaii. (Age 32) (Claims RCA 4.6) 1938 to date Jun. Engr., U.S. Engr. Dept., 1937 to 1938 Research Scholar (McMullin Scholarship), Cornell Univ.; previously with U.S. Forest Service.

BULLOCK, CARLOS DEWITT (Junior), Vinita, Okla. (Age 32) (Claims RCA 4.5 RCM 5.1) July 1938 to date with FWA, until September 1938 as Asst. Structural Engr., P.B.A., then with PWA as Associate Engr., and (since April 1940) Engr., Project Engr.'s office; previously with TVA, Knoxville, Tenn.

COLE, EDWARD SHAW (Junior), New York City. (Age 32) (Claims RCA 2.6) April 1934 to Sept. 1938 and Nov. 1939 to date with The Pitometer Co., Engrs.; in the interim graduate student and with Reeves Newsom, Engr. Consultant, New York City.

CRESSWELL, FREDERICK SORENSEN (Junior), Alexandria, Va. (Age 32) (Claims RCA 1.6) Sept. 1939 to date Engr. in charge of promotional campaign, Clay Sewer Pipe Association, Inc., Pittsburgh, Pa.; previously with PWA as Eng. Clerk, Asst. Engr. Examiner, and Engr. Examiner.

DAMMAN, HAROLD HENRY, Seattle, Wash. (Age 54) (Claims RCA 8.0) April 1930 to date with State of Washington, Dept. of Public Service (6 months) and Highway Dept., at present as Res. Engr. Inspector.

DEAN, GEORGE THOMAS, Manhattan, Kans. (Age 32) (Claims RCA 1.0) At present Graduate Asst., Civ. Eng. Dept., Kansas State Coll.; previously Instrumentman with Kansas Highway Comm., and Missouri Highway Dept.

FITZGERALD, JOHN PAUL, Jackson Heights, N.Y. (Age 34) (Claims RCA 6.0) July 1940 to date Asst. Designer, Hull Dept., George G. Sharpe, Naval Archt., New York City; previously Engr., North Beach Airport Field Office, Jackson Heights, N.Y.; Asst. Engr., Eng. Design Sec., WPA, New York City.

FLINT, RAYMOND EUGENE (Junior), Mahopac, N.Y. (Age 27) (Claims RCA 4.2) April 1937 to date with Frazier-Davis Constr. Co., New York City, since July 1937 as Engr. on Delaware Aqueduct Contract 321; previously with Webster Groves (Mo.) San. Sewer Dist.

FRASER, ROBERT HAMILTON (Junior), New York City. (Age 27) (Claims RCA 1.6 RCM 2.0) Sept. 1939 to date with Chemical Constr. Corporation as Structural Engr. and Draftsman, and (since May 1940) Estimating Engr.; previously with New York City Omnibus Corporation as Asst. Engr., Equipment Maintenance and Bldg. Depts.

FULLER, THEODORE ALBERT, San Benito, Tex. (Age 31) (Claims RC 2.0 D 5.8) Nov. 1936 to date Jun. Engr., U.S. Dept. of State, International Boundary Comm., United States and Mexico; previously Project Supt., U.S. Dept. of Agriculture, Belton, Tex.

GONZALEZ, MANUEL FRANCIS (Junior), Pensacola, Fla. (Age 32) (Claims RCA 8.0) Oct. 1931 to March 1932, April 1932 to Feb. 1933 and May 1934 to date with Smith Eng. & Constr. Co., as Instrumentman, Asst. Supt., and (since Jan. 1936) Supt.

GREENLEAF, LEE MOSES, Bedford, Pa. (Age 32) (Claims RCA 5.1 RCM 0.4) March 1939 to date with Pennsylvania Turnpike Comm. as Div. Concrete Engr. and (since March 1940) Asst. Chf. Tunnel Engr.; previously with TVA.

HAWKE, JAMES PHILIP, Little Rock, Ark. (Age 29) (Claims RCA 2.4) May 1934 to date with U.S. Engr. Dept., in various positions, since March 1940 being Assisting Head of Foundations Sec.

HOYT, WARREN HIRAM, Emeryville, Calif. (Age 32) (Claims RCA 3.7) Feb. 1936 to date Asst. City Engr., Emeryville, Calif.; previously Jun. Bridge Engr., U. S. Forest Service.

JEWETT, GEORGE EDGAR (Junior), New York City. (Age 32) (Claims RCA 4.6) March 1937 to date with Chicago Bridge & Iron Co., Structural Draftsman, etc., and (since April 1940) in Sales Dept.; previously Designer, U.S. Engrs., Los Angeles, Calif.

JOHNSON, ARTHUR DELAFIELD (Junior), Honolulu, Hawaii. (Age 32) (Claims RCA 3.4) July 1938 to Aug. 1939 and Oct. 1939 to date with Public Works Office, U.S. Navy as Senior Structural Eng. Draftsman, San Diego, Calif., and (since Oct. 1939) Chf. Eng. Draftsman, Pearl Harbor, Hawaii; previously with F. E. Young, Gen. Contr., and Wm. P. Lodge, Archt., San Diego.

JOHNSON, HORACE ALLISON (Junior), Glendale, Calif. (Age 32) (Claims RCA 4.7) May 1938 to date with U.S. Engr. Dept., Los Angeles, Calif. as Jun. Engr., and (since Sept. 1939) Asst. Engr.; previously with U.S. Bureau of Reclamation.

LIM, PHEK CHOO, Singapore, S.S. (Age 35) (Claims RCA 2.8) July 1931 to date with Water Dept., Municipality of Singapore as Chf. Waste Inspector, Dist. Inspector, and (since March 1938) Supt. of Waste Detection.

MOORE, PAUL BLACKSTONE, Carlsbad, N.Mex. (Age 54) (Claims RCA 18.4 RCM 7.2) March 1936 to date Engr. Inspector, PWA; previously in private practice at Albuquerque and Magdalena, N.Mex.

O'FARREL, JOHN JOSEPH (Junior), Marion, Ohio. (Age 32) (Claims RCA 1.2) July 1929 to Dec. 1931 Draftsman, and Oct. 1932 to date Asst. Cost Engr. with The Chesapeake & Ohio Ry. Co.

OLISZEWSKI, CASIMIR (Junior), Clarion, Mich. (Age 32) (Claims RCA 4.5) March 1934 to Sept. 1937, March to Dec. 1938 and Aug. 1939 to date with Corps of Engr. Reserve, U.S. Army, successively as 2d Lieut., 1st Lieut. with CCC, Commanding Officer, and (since Aug. 1939) CCC Co. Commdr., Adjutant General's Dept.

RAYNER, OLIVER GREENLAW, Atlanta, Tex. (Age 34) (Claims RC 6.9 D 3.9) April 1931 to date with Texas Highway Dept., as Instrumentman, Office Engr., Asst. Res. Engr., and (since May 1940) Jun. Res. Engr.

REIDY, PETER JOSEPH, Jackson Heights, N.Y. (Age 40) (Claims RCA 8.5 RCM 2.2) Aug. 1919–Dec. 1933 with Purdy & Henderson Co., Inc., and Jan. 1934 to date member of firm, Purdy & Henderson Associates, Inc., since Jan. 1940 being Director and Treas.

SPENCER, CHARLES BRENNARD (Junior), New Orleans, La. (Age 32) (Claims RCA 6.4) June 1938 to date Asst. to William T. Nolan, Archt. and Engr.; Nov. 1937 to June 1938 Layout Engr., George A. Fuller Co., Contrs., Washington, D.C.; previously with Doullut & Ewin, Engrs. and Contrs.; Res. Engr., Weil & Moses, Cons. Engr., Pittman Bros. Constr. Co., Contrs. and U.S. Engr. Dept.

STAUBLE, JOHN HENRY, Cascade, Trinidad, B.W.I. (Age 31) (Claims RCA 4.8) Nov. 1938 to date Asst. Engr., City Eng. Dept., Port of Spain; previously Asst. Engr., Edmund Nuttall Sons & Co. (Manchester Ltd.)

STRANGE-BOSTON, ARCHIBALD DONALD, Shreveport, La. (Age 47) (Claims RCA 16.6 RCM 4.6) 1925 to 1932 and 1934 to date with Standard Oil Co. of Louisiana, Pipe Line Dept. as Draftsman, Estimator and Architectural Designer, and (since 1934) Engr.-Draftsman.

SWARTWOUT, WILLIAM HENRY, JR., Brooklyn, N.Y. (Age 36) (Claims RCA 4.8) April 1938 to date Eng. Asst., New York City Tunnel Authority; previously Senior Supt., WPA.

SWEET, JAMES SIMEON, Albany, N.Y. (Age 39) (Claims RCA 2.8 RCM 0.7) Sept. 1938 to date with U.S. Weather Bureau as Asst. Hydrologic Engr., Hydrometeorological Sec., River and Flood Div., and (since Jan. 1940) Acting Hydrologic Supervisor, North Atlantic Hydrologic Region; previously Jun. Hydr. Engr., U.S. Geological Survey.

TAHER, MAHMOOD KHAN, Boulder, Colo. (Age 30) (Claims RC 1.3) Nov. 1934 to July 1938 in Diplomatic Service, Iranian Legation, and student, George Washington Univ., Washington, D.C., and July 1938 to June 1940 student, Univ. of Colorado; previously with Ministry of Roads, Iranian Govt. as Technician.

THIEBAUD, MEDILL PIERRE, Sacramento, Calif. (Age 32) (Claims RCA 2.3) July 1938 to date Asst. Hydr. Engr., California Div. of Water Resources; previously with U.S. Forest Service, California Div. of Highways, U.S. Bureau of Biological Survey, U.S. Bureau of Reclamation, etc.

TRAVIS, WAYNE IVAN (Junior), Iowa City, Iowa. (Age 32) (Claims RCA 4.7 RCM 1.5) Aug. 1930 to date with U.S. Geological Survey as Jun. Engr., Asst. Engr., and (since June 1940) Associate Engr., being First Asst. to Dist. Engr.

TUSSING, JOHN ALEXANDER, Catonsville, Md. (Age 34) (Claims RCA 10.9) May 1940 to date Asst. to Chf. Engr., Baltimore (Md.) Steel Co.; previously with U.S. Treasury Dept. as Asst. Engr. (Structural) and Associate Engr. (Structural), and with FWA as Associate Engr. (Structural).

WAINWRIGHT, CY HAYDEN, Cherry Creek, Nev. (Age 32) (Claims RCA 2.6) Dec. 1939 to date Camp Engr., Grazing Service, CCC; previously Jun. Engr., PWA, Region 6; Water Commr., State of Nevada.

WILLEY, WILLIAM EDWARD, Phoenix, Ariz. (Age 31) (Claims RCA 2.0) April 1933 to date with Arizona State Highway Dept. as Res. Engr. and Draftsman.

WILLIAMSON, JOE, JR., St. Louis, Mo. (Age 34) (Claims RCA 3.0 RCM 5.4) June 1929 to date with Russell and Axon, Cons. Engr., as Draftsman, Designer, Inspector, and (at present) Vice-Pres.

WRAY, WILLIAM JACKSON, Manning, S.C. (Age 33) (Claims RCA 4.2 RCM 4.7) Jan. 1936 to March 1937 and April 1938 to date Asst. Res. Engr. Inspector, PWA; in the interim Engr. Inspector, Pennsylvania R.R., Philadelphia, Pa.; previously Superv. Engr., State Rural Electrification Authority, Columbia, S.C.

APPLYING FOR JUNIOR

DUNN, EMMETT WATERS, JR., Mobile, Ala. (Age 30) Oct. 1938 to date with War Dept. U.S. Engr. Office as Jun. Eng. Aide, Flood-Control Sec., and (since Dec. 1939) Asst. Eng. Aide; previously with AAA, Nashville, Tenn.

EVANS, HENRY KING, Los Angeles, Calif. (Age 23) 1938 B.S. in Civ. Eng., Calif. Inst. Tech. June 1939 to date Field Representative, Public Safety Dept., Auto Club of So. California.

GREEN, HERBERT SPENCER, Charleston, S.C. (Age 27) Nov. 1938 to date Jun. Engr., Harza Eng. Co.; previously Eng. Draftsman, TVA; Rodman, City of Trenton, N.J.

GURTLER, MARTIN MATHIAS, II, New Orleans, La. (Age 24) 1937 B.S. in C.E., Tulane Univ.; May 1939 to date Vice-Pres. & Chf. Engr. Substrata Engrs., Inc., Chf. Engr., Le Mieux Bros., Inc., and Cons. Engr., Clero Foundations Inc. (allied companies).

HAMLYN, WILFRED THOMAS, El Paso, Tex. (Age 27) (Claims RCA 0.2) 1936 B.S. in Min. Eng., Tex. Coll. of Mines and Met. 1938 M.S. in Mineral Dressing, Montana School of Mines; Nov. 1936 to Sept. 1937 and June 1938 to May 1939 with International Boundary Comm.; May 1939 to date Office Engr., Texas State Highway Dept.

HUME, VIRGIL LAWRENCE, Lorain, Ohio. (Age 23) (Claims RCA 0.2) June 1939 to date with T. J. Hume Co., general building construction.

LEWIS, ROBERT LOYD, Fort Collins, Colo. (Age 27) (Claims RCA 2.8) Sept. 1936 to date with Dept. of Civ. Eng., Colorado State Coll. as Instructor and (since Sept. 1937) Asst. Prof.; previously Rodman, Colorado State Highway Dept.

OLTMAN, ROY EDWIN, St. Paul, Minn. (Age 28) May to Dec. 1934, April to Oct. 1935 and June

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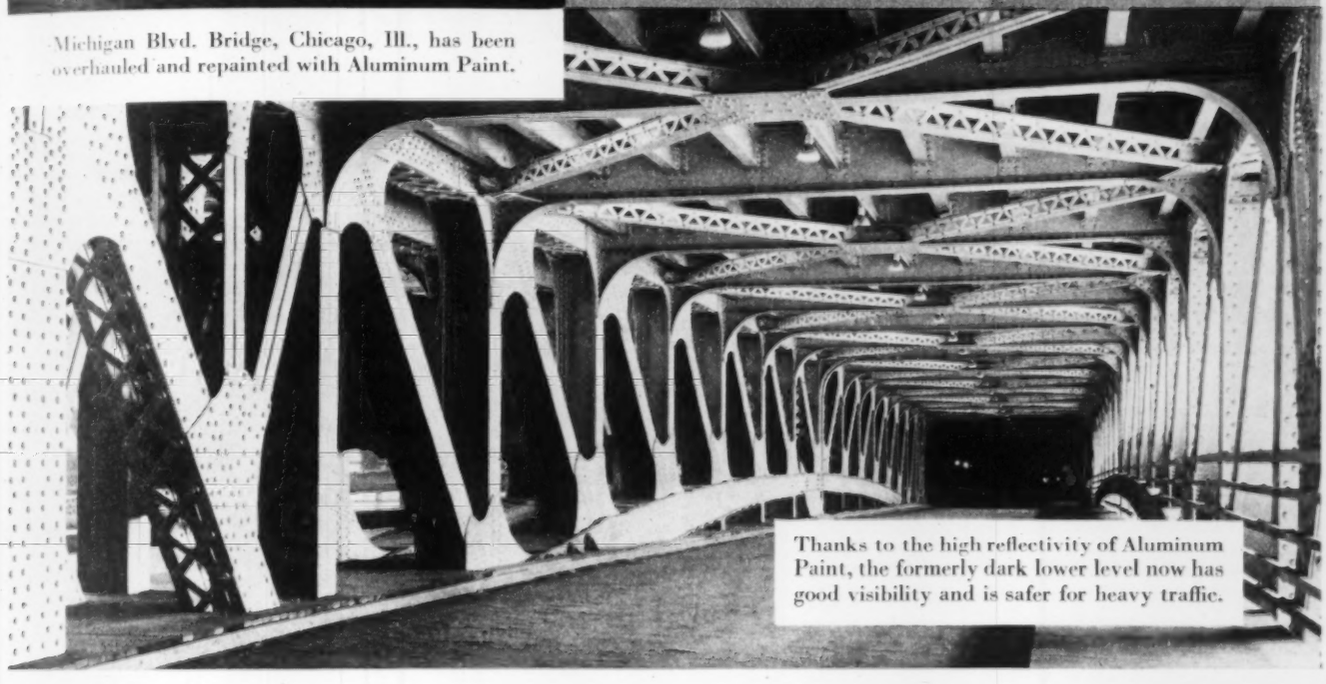

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1938 to date with U.S. Geological Survey as Rodman, Jun. Topographic Engr., and (since June 1938) Jun. Hydr. Engr., Water Resources Branch; in the interim with Chicago, St. Paul, Minneapolis & Omaha and Great Northern Rys.

SCISSON, SIDNEY EUGENE, Tulsa, Okla. (Age 23) 1939 B.S. in Gen. Eng., Oklahoma A. & M. Coll.; at present Eng. Aide (Civ.), U.S. Engr. Office, Tulsa, Okla.

TURNER, JOHN KENDRICK, Knoxville, Tenn. (Age 29) (Claims RCA 2.5) Dec. 1934 to date with TVA as Jun. Eng. Aide, Asst. Eng. Aide, Jun. Hydr. Engr., and (since July 1939) Asst. Hydr. Engr.

1940 GRADUATES

ALA. POL. INST.
(B.S. in C.E.)

	AGE
ALDRIDGE, LOUIS ROLLINS, JR.	(20)
BROWN, CHRISTOPHER CRAYTON	(22)
SCARBROUGH, BEN ALLEN	(21)
SCRIVNER, JAMES DANIEL	(22)

CALIF. INST. TECH.
(M.S. in Civ. Eng.)

BORGQUIST, NEIL ERASMUS (22)
(Also 1939 B.S. in Civ. Eng., Univ. of Ariz.)

UNIV. OF CALIF.
(B.S. in Civ. Eng.)

BACON, VINTON WALKER	(23)
BEER, CHARLES GROVER	(24)
BLISS, ROBERT T.	(22)
BRADY, WILLIAM HENRY	(25)
BURK, PETER WILLIAM, JR.	(21)
CAMPBELL, ROBERT RUSSELL	(22)
CHENEA, PAUL FRANKLIN	(22)
CONRADSEN, HAROLD	(23)
DALGLEISH, CHARLES EDWIN	(23)
DOUGHERTY, GALE BARKMAN	(22)
DUNLAP, JAMES EDWARD	(24)
GATOW, HAROLD	(21)
GESLEY, HOWARD ROBERT	(25)
HENCK, JOSEPH PUTNAM	(22)
HONNOLD, HAROLD LELAND, JR.	(25)
HOPPE, CHARLES FRANKLIN, JR.	(21)
HULL, CLIFFORD CLEVELAND	(23)
IVANCOVICH, WAYNE WILLIAM	(24)
JONES, MILTON HOMER, JR.	(22)
LEICHTFUSS, WALTER ARTHUR	(23)
LONERGAN, RICHARD PHILIP	(23)
MATTHEWS, WILLIAM JAMES	(26)
MAY, EDGAR ORIS	(22)
MINER, ARTHUR WILLIAM	(23)
MORTON, ROBERT NORCROSS	(23)
NILMEIER, HERBERT PHILLIP	(24)
NISHKIAN, BYRON LEON	(24)
PETERSON, EDWARD WALLACE	(22)
POSTHUMUS, GEORGE	(24)
POULSEN, FRANK	(24)
PUELING, RONALD WILSON	(20)
RICHEY, VERNON JAY	(20)
RIEFE, NORMAN TERRY	(23)
ROYCE, ARTHUR FREDRIC	(23)
SANKS, ROBERT LELAND	(24)
SANTRY, ISRAEL WOOTAN, JR.	(23)
SCHULTZ, DONALD PARKER	(22)
SPORE, JAMES SUTHERLAND	(23)
STEIN, LEON	(20)
STETSON, CARL LEO, JR.	(21)
TAKAYAMA, SHIGEO JULIUS	(23)
THOMAS, IVOR REES	(23)
WATSON, ARTHUR REID	(21)
WING, DAVID WONGCHUNG	(27)
WOODCOCK, LORIN FRED	(21)
YOSHIZAWA, HAJIME	(22)
ZANCAI, EGISTO FRED	(21)

CASE SCHOOL OF APPLIED SCI.
(B.S. in Civ. Eng.)

CONVERSE, FRANK PORTER, JR.	(21)
ENGLER, ALBERT ERNEST	(23)
ESCH, JAMES GEORGE, JR.	(23)
HAMLIN, WILLIAM GILBERT	(21)
MANSELL, BERT EVAN	(23)
PELTIER, FREDRIC EUGENE	(22)
RAU, WILLIAM LLEWELLYN, JR.	(21)
WOOD, RALPH LENARD	(22)

CATHOLIC UNIV. OF AMERICA
(B.A.E.)

MURPHY, JOHN JOSEPH (23)

(B.C.E.)

LEWIS, LESTER MARX	(20)
VINER, ROBERT VICTOR	(22)

THE CITADEL
(B.S.)

LAGARDE, PAUL MICHINARD (22)

COLO. STATE COLL.
(B.S. in C.E.)

BELL, AMBROSE PETER	(24)
GIDDINGS, RALPH LEANDER, JR.	(22)
HILL, GORDON EUGENE	(23)
TRAINOR, EDWARD THOMAS	(24)
ZICK, LEONARD PAUL, JR.	(22)

UNIV. OF COLO.
(B.S. in Arch. Eng.)

HARRIS, ROBERT BLYNN (21)

(B.S. in Civ. Eng.)

BOCK, PAUL KENNETH (22)

COLUMBIA UNIV.
(B.S. in Civ. Eng.)

GOODMAN, LAWRENCE EUGENE (20)
(Also 1939 A.B.)

(B.S.)

GUIZOT, APOLLO (21)

CORNELL UNIV.
(C.E.)

GAY, WILLIAM ARTHUR (22)

GA. SCHOOL TECH.
(B.S. in Civ. Eng.)

JOHNSON, ROBERT LINDER, JR.	(23)
PARIS, WALTER EDWIN	(23)
PORTER, HOWARD EUGENE	(22)

HARVARD UNIV.
(M.S. in Civ. Eng.)

KRASON, FERDINAND CAROL (22)
(Also 1939 B.C.E., N.Y. Univ.)

IOWA STATE COLL.
(B.S. in Civ. Eng.)

AKINS, JOHN C.	(21)
KING, RALPH WENDON	(21)
MORGAN, HARRY S.	(25)

STATE UNIV. OF IOWA
(B.S. in Civ. Eng.)

BOWMAN, JAMES WILLIAM	(21)
WISE, PAUL WILMOTH	(23)

JOHNS HOPKINS UNIV.
(B.C.E.)

BOYER, WALTER CHARLE BERNARD	(21)
CHAPMAN, JOHN SPENCE HAYES	(21)
DISKIN, SIMON HYMAN	(21)
EWELL, WALTER WORTHINGTON	(20)
WENK, EDWARD, JR.	(20)

KANS. STATE COLL.
(B.S. in Civ. Eng.)

AMOS, BRUCE LOGUE	(25)
DELP, LARUE ELDRED	(29)
FOREMAN, CHESTER ALANSON	(24)
FULLER, JACK PEARSON	(23)
GARRELTS, CLEMENT DALE	(22)
KAUFMAN, ALVIN DANIEL	(24)
LILL, WAYNE PERCY	(25)
NELSON, GLENN RUSSELL	(24)
PETERIE, LESTER LEROY	(27)
REID, DONALD DORMAN	(25)
SHILLING, MERLE MATHIAS	(28)
VAUGHT, GEORGE WILLITS	(22)

UNIV. OF KANS.
(B.S. in Civ. Eng.)

CLARK, JOSEPH MILLER	(21)
DAVIS, WILLIAM BARRY	(28)
METZLER, DWIGHT FOX	(24)

LA. STATE UNIV.
(B.S. in Civ. Eng.)

GAMBLE, WILLIAM ARTHUR	(24)
JESSEN, DIETRICH WALTER	(24)
MAYER, MAYER, JR.	(23)
SAMUELSON, HYMAN	(21)

MARQUETTE UNIV.
(B.C.E.)

MAKAL, THOMAS JOSEPH	(23)
WINKLER, JOHN ROBERT	(22)

UNIV. OF MD.
(B.S. in C.E.)

CARROLL, RICHARD WESTLEY	(21)
CRANFORD, LEONARD CARTER	(22)
WILSON, JOHN GIBSON, JR.	(25)

MASS. INST. TECH.
(S.B.)

BITTENBENDER, ROBERT AUSTIN	(23)
CASEY, JOHN JOSEPH, JR.	(21)
WRIGHT, HOLLIS GARRETT	(23)

UNIV. OF MICH.
(B.S. in C.E.)

ANTON, JOSEPH	(23)
BURDICK, JEROME EDWARD	(24)
BUSH, MERRILL MAYES	(21)
CLAUSER, HENRY RAY	(23)
DENNIS, WALTER ARTHUR	(25)
GRAVER, ROBERT WILLIAM	(22)
HORNER, JAMES RUSSELL	(22)
QUINSEY, THOMAS EVANS	(24)
RANE, JOHN WILLIAM, JR.	(22)
RIEGER, WALTER HERMAN	(23)
TORZYNSKI, THADEUS THEODORE	(23)

(M.S.E.)

DJIVELEKOGLU, SHAHAN (23)
(Also B.S. in C.E., Robert Coll.)
ZAHID, FUAD AHMED (24)
(Also B.S. in C.E., Robert Coll.)

UNIV. OF MINN.
(B.C.E.)

ANDERSON, DEAN MYRIN	(23)
ARCHIBALD, CHARLES DOUGLAS	(23)
AUER, JEROME LEO	(26)
BANG, SVEND AAGE	(21)
EKREM, NORVIN EDWARD	(24)
FREDRICKSEN, ROY ELDON	(21)
HANSEN, HAROLD WOODROW	(23)
LAUER, ALBERT JOSEPH	(22)
MCENARY, ROBERT REED	(21)
PELTON, LYNN ALLEN, JR.	(21)
WARNER, MARVIN ELLSWORTH	(22)

MISS. STATE COLL.
(B.S.C.E.)

SHAW, PHILIP WALKER (22)

UNIV. OF MISS.
(B.S. in C.E.)

WORSHAM, LEROY WESLEY (21)

MO. SCHOOL OF MINES & MET.
(B.S.C.E.)

PALMER, CLARENCE CHILDS (22)

UNIV. OF N.H.
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DAVIDSON, DONALD THOMAS	(21)
LOISELLE, DONALD WILLIAM	(22)
SHEAHAN, EDMUND CORBETT	(21)

COLL. OF CITY OF NEW YORK
(B.C.E.)

HODOSH, HERBERT RICHARD	(20)
MCEVOY, ROBERT WILLIAM	(21)
RUHRORT, WILHELM HANS	(21)
WIESENFELD, JOEL	(22)

N.Y. UNIV.
(B.C.E.)

SMITH, EDGAR FIELD (25)

(M.C.E.)

GERARDI, ANGELO PETER (21)
(Also 1938 B.C.E., Coll. of City of N.Y.)

UNIV. OF N.DAK.
(B.S. in C.E.)

GAHR, WILLIAM NICHOLAS (30)

NORTHEASTERN UNIV.
(B.S. in Civ. Eng.)

CONLIN, DANIEL JOSEPH	(24)
CORCORAN, WILLIAM JOSEPH	(24)
DECKER, WILMOT HUNTER	(23)
GILL, JOHN JOSEPH	(23)
GRADY, WALTER THOMAS	(23)
HARDY, WILLIAM LOWTHER	(22)
MILES, DANIEL WALTER	(23)
REINIGER, LOUIS GERARD	(23)
SEELEY, HENRY GEORGE	(24)
VAN TUYL, DONALD WELLS	(22)

NORTHWESTERN UNIV.
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HANLINE, CHARLES FRANCIS	(22)
METCALF, COBURN CHAPMAN	(22)
WEAVER, RALPH EARL	(25)

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HUSTED, HAROLD BENJAMIN	(21)
PERMAR, DAVID ROBERT	(21)
SKELTON, LEWIS ROSCOE	(23)

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(B.S. in Civ. Eng.)

HYND, MORRISON (23)

ORE. STATE COLL.
(B.S. in Civ. Eng.)

KRANICK, MARTIN EVERETT	(20)
MELSON, LEWIS BYRON	(26)
SHAVER, JOHN WATSON	(24)

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KANY, ROBERT CARL (22)

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CAO-GARCIA, JOSE CELSO	(23)
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HUNT, CHARLES WILLIAM (24)
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JOHNSON, CORT THOMAS (22)
JONES, KEITH (29)
LAGOS, JIM C. (24)
MCGEE, LESLIE LEE (25)
MCNEESE, DONALD CHARLES (23)
SMITH, WAYNE WINTER (24)
TRESLER, GEORGE WILSON, JR. (21)

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Personnel Service, Inc., with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 132 of the 1940 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 41; married; graduate civil engineer; 20 years experience field and office; railroad engineering; location, construction, and maintenance, including over 10 years responsible charge; now employed; desires connection with opportunity for advancement. C-752.

CIVIL ENGINEER; M. Am. Soc. C.E.; registered; 35 years experience in general engineering, including water works, sewers, paving, railways, industrial plants, hydroelectric plants, transmission lines; location, construction, maintenance, valuations, appraisals, etc. Foreign experience in West Indies and South America, and war-time construction in France. Available now, preferably in United States. C-759.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 34; technical school graduate; trained at Purdue, and Polytechnic Institute of Brooklyn; graduate of Battery Officers' Course, Coast Artillery School; formerly engineer-in-charge of layout of large state park; desires to enter city planning field in which he has had some experience. At present with federal government on flood control work. C-760.

EXECUTIVE

ENGINEER-EXECUTIVE; M. Am. Soc. C.E.; 49; married; 25 years experience on heavy construction; at present assistant chief engineer for firm of contractors, specializing in difficult foundations, pneumatic caisson, heavy steel erection, large river bridges, heavy pile driving; experienced in construction designing, estimating, bidding, and supervision; desires responsible administrative position. C-750.

STRUCTURAL ENGINEER; M. Am. Soc. C.E.; 27 years experience with structural steel fabricators, contractors, engineers; 2 years detailing; 25 years estimating, designing, selling, managing structural steel business; experienced in all branches of structural steel industry, designing all kinds of buildings, industrial plants for architects and engineers. Desires position with structural steel fabricators, contractors, engineers, architects, or industrial plants. C-753.

CIVIL ENGINEERING ADMINISTRATOR AND TEACHER; M. Am. Soc. C.E.; 59; over 20 years successful experience as head of civil engineering departments and dean in East and Southwest; 8 years public works experience in charge of design and supervision; 10 years miscellaneous engineering, business experience including World War army service; available for engineering executive or teaching. C-757.

CIVIL ENGINEER; M. Am. Soc. C.E.; graduate of Rensselaer Polytechnic Institute; licensed; 31 years experience in harbor work of all kinds; industrial plants; bridges; refineries; cold storage; power plants; planning; layout; design; and supervision. Will go anywhere, preferably Northwest; prefer to be with consulting engineer. C-758.

JUNIOR

CIVIL ENGINEER; 25; Jun. Am. Soc. C.E.; B.S. in E. "cum laude," 1935; C.E., 1935; 2 years office; 2 years field on highways, grade separations, bridges, bulkheads, dredging, sewers, buildings, conveyor system; 1 year full time, and 1 year part-time college teaching engineering subjects; desires design opportunity in New York City. C-752.

CIVIL ENGINEER; Student Chapter member; 23; single; B.S.C.E. and B.S. in commercial engineering, University of Nebraska, 1940; lieutenant, Corps of Engineers, U.S. Army Reserve; general business experience covering financial, management, and purchasing; particularly interested in the fields of city planning and municipal engineering; location immaterial. C-762.

MUNICIPAL

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; New York license; 25 years experience on water works and municipal, park, and road work, both construction and maintenance; qualified to lay out, design, supervise, construct, and make reports; familiar with budgets, accounting, and administration. Available to go anywhere as engineer or assistant. C-755.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., University of Illinois, 1940; major in municipal and sanitary engineering (good scholastic record); desires sanitary work; 3 months as instrumentman in field party; 5 months in highway research. Now employed but available on short notice; will go anywhere. C-756.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; B.C.S., Ohio State University; Ohio professional engineer's license; 31; married; 8 years highway experience; 6 years preparation of plans and designing; 2 years surveys and project engineer; 4 years responsible charge. Interested in highway safety engineering; employed but available on short notice; references. C-761.

TEACHING

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 38; married; registered in California; B.Sc.; M.Sc.; Chi Epsilon; Geophysical Union; 6 years teaching in major university; 9 years hydraulic, hydroelectric, general construction, and design experience; 1 year resident highway engineer; 1 year and now employed by independent United States commission. Position with future desired as professor, contractor's engineer, or in consulting office. C-754.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room will be found listed here. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

INDEX TO THE PROCEEDINGS, JOURNAL AND OTHER PUBLICATIONS OF THE AMERICAN WATER WORKS ASSOCIATION, 1881–1939 inclusive. American Water Works Association, New York, 1940. 285 pp., 9 × 6 in., cloth, $1.75 to members ($1.50 if cash is included with order); $2 to non-members.

The publications of the American Water Works Association, from its beginning in 1881 through 1939, are indexed. All published papers are listed chronologically under seventy major subjects of the water works field. There are also an author index, a guide to the topics in the subject index, and descriptions of other publications issued by the Association alone or in cooperation.

INDUSTRIAL DESIGN. By H. Van Doren. McGraw-Hill Book Co., New York, 1940. 388 pp., illus., diagrs., charts, tables, 9½ × 6 in., cloth, $4.50.

This book is presented as a practical textbook on industrial design, but it is anticipated that it will be useful to the engineer, commercial artist, and business man as well. Part I outlines the scope of the work, the difficulties, and something of its possibilities. Part II is an elementary treatise on designing in three dimensions. Technique is dealt with in Part III, which covers the gathering and presentation of data and ideas, information on materials and processes, etc. Part IV offers problems, including possible solutions, and gives case histories of the development of three actual products.

NATIONAL RESEARCH COUNCIL. HIGHWAY RESEARCH BOARD, Proceedings of the Nineteenth Annual Meeting held at Washington, D.C., December 5–8, 1939. Edited by R. W. Crum. National Research Council, Washington, D.C., 1940. 578 pp., 10 × 6½ in., cloth, $2.25.

In addition to official information about the Highway Research Board, this volume contains over 500 pages of papers, discussions, and reports presented at the 1939 meeting. This material is arranged by departments under the headings: finance; economics; design; materials and construction; maintenance; traffic and safety; and soils. Some papers have bibliographies, and there is an author index.

OUTLINE OF INDUSTRIAL RELATIONS POLICIES IN DEFENSE INDUSTRIES. Princeton University (Industrial Relations Section), Princeton, N.J., 1940. 47 pp., 10 × 7 in., paper, 75 cents.

Brief discussion and reported experiences are presented on the following topics: expansion of management organization; recruitment of production workers; training of skilled and semi-skilled workers; wages and hours of work, and employee-management cooperation in accelerated production. There is a selected bibliography.

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Abstracts of Articles on Civil Engineering Subjects from Publications (Except Those of the American Society of Civil Engineers) in This Country and in Foreign Lands

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BUILDINGS

ACCIDENT PREVENTION. Safety Out-of-Doors. *Safety Eng.*, vol. 79, no. 5, May 1940, pp. 18–19. Safety schedule for 1940 at New York World's Fair; notes on safety record achieved for 1939; building and structural design credited with making for accident prevention.

BUILDINGS, WRECKING. Wrecking Chicago Landmark. *Eng. News-Rec.*, vol. 124, no. 19, May 9, 1940, pp. 76–79. Methods and equipment used in demolition of 14-story Great Northern Hotel on line of new subway of Chicago, Ill.; partition removal; steel salvage; safety measures.

GARAGES, MOVING. 10,000-Ton Building Side-Steps Street Widening. *Construction Methods*, vol. 22, no. 6, June 1940, pp. 52–53, 86, and 88. Methods and equipment used in moving 10,000-ton, 4-story steel-frame building, 327 ft by 65 ft wide, housing Central Square Garage, Pittsburgh, Pa., to new foundation 27 ft from its original location.

MUSEUMS, NAVAL. Planned Marine Museum. C. M. Gay. *Franklin Inst.—J.*, vol. 229, no. 5, May 1940, pp. 567–583. Museum of Franklin Institute in Philadelphia, in planning their Hall of Marine Transportation, found that exhibits should illustrate course of development of American maritime art from days of discovery of continent to present time; collection contains examples of chief types of ships and navigating equipment of today.

LAND RECLAMATION AND DRAINAGE

PUMPING PLANTS. Pumps for Irrigation and Drainage Plants. *Sulzer Tech. Rev.*, no. 1, 1940, pp. 6–14. Points characteristic for design and construction of pumps are maximum possible absorption capacity, large cross-sectional areas of flow in impeller and pump casing, and finally high speeds in order that cost of machines driving them may be kept as low as possible; types described.

MATERIALS TESTING

CONCRETE. Predicting Concrete Strengths, L. R. Davies-Graham. *Commonwealth Engr.*, vol. 27, no. 10, May 1, 1940, pp. 335–338. Results of laboratory and field tests carried out on 10 Australian cements, leading to conclusion that there is every prospect of accelerated 8-hour test being used to forecast 28-day concrete strength.

CONCRETE, CRACKING. Attempts to Measure Cracking Tendency of Concrete, R. W. Carlson. *Am. Concrete Inst.—J.*, vol. 11, no. 6, June 1940, pp. 533–537. Description of method for determining resistance to cracking of concrete subjected to drying; preliminary results of tests; effect of duration of moist curing, type of aggregate, cement content, air-entraining agents, etc.

CONCRETE MIXING. Revised Application of Fineness Modulus in Concrete Proportioning, H. L. Kennedy. *Am. Concrete Inst.—J.*, vol. 11, no. 6, June 1940, pp. 596–613. Outline of method of concrete proportioning in which trial mixes are used only for purpose of final adjustment of mix parts, and fineness modulus is used only as measure of effective fineness of combined aggregate to facilitate testing and control; tests for compressive strength or other properties used as check of mix design.

ROAD MATERIALS. Contributo allo studio delle malte bituminose, G. Quaglia and L. Baschieri. *Ricerche di Ingegneria*, vol. 7, no. 6, Nov.–Dec. 1939, pp. 171–185. Report on original Italian experimental studies of bituminous mixtures for road construction, for purpose of developing mixture of maximum compactment; effect of shape of particles on volume of voids in sand; physical properties of mixtures of filler and bitumen; tests of bituminous pavement samples taken from streets of Pisa, Italy.

SOILS. Les essais de géophysique pour la mesure des propriétés des sols et des terrains, Y. Poisson. *Génie Civil*, vol. 116, nos. 3011 and 3012, Apr. 27, 1940, pp. 276–280, and May 4, pp. 291–294. Review of modern European and American field in laboratory practice for testing of physical properties of soils and foundations; sampling methods; physical soil analysis; plasticity tests; shearing and compression tests; permeability tests.

MUNICIPAL ENGINEERING

BEACHES, EROSION. Hawk's Nest Beach, Connecticut. *Shore & Beach*, vol. 8, no. 1, Jan. 1940, pp. 14–22. Investigation of erosion at Hawk's Nest Beach, Old Lyme, Conn.; currents and winds; wave action; protective structures; hurricane dangers; shoreline and offshore changes; current measurements made by subsurface floats.

PORTS AND MARITIME STRUCTURES

GREAT LAKES. Port of Duluth–Superior, Minn. and Wis. *U.S. Army Corps Engrs.—Lake Series No. 6*, 1940, 148 pp., supp. plates. $1. Revised report on port of Duluth–Superior, containing data showing movements of commerce through port, facilities available for handling traffic, and rates and charges applying against it.

PORTUGUESE EAST AFRICA. Extensions to Port of Beira. *Engineer*, vol. 169, no. 4399, May 3, 1940, pp. 411–413, and 418. Illustrated description of construction of two additional berths, each 600 ft long, forming extension of deep water wharves and making total wharfage of 2,695 ft; reclamation of land behind wharves, and erection of two transit sheds, necessitating widening of wharves.

ROADS AND STREETS

AIRPORT RUNWAYS. Omaha Airport Runways, W. H. Campen. *Roads & Streets*, vol. 83, no. 5, May 1940, pp. 62, 64, 66, and 68–69. Tests and observations on construction and performance of Omaha, Nebr., airport runways, totaling approximately 200,000 sq yd; preliminary laboratory work on subgrade and sub-base soils; load-bearing value and moisture content relations; selection of soils for sub-base; construction of base; characteristics of sub-base and base after one year's actual use.

AIRPORTS, CONSTRUCTION. Important Considerations in Airport Construction, W. S. Housel. *Roads & Bridges*, vol. 78, no. 5, May 1940, pp. 22–23 and 79–80. General discussion of bearing of highway engineering experience on construction of modern airports; practical illustrations. Before Am. Road Bldrs. Assn.

BITUMINOUS. Sealing Oil Mat-Surfaces, D. L. Cheney. *Eng. News-Rec.*, vol. 124, no. 25, June 20, 1940, p. 65. Description of new type of oil-mat roads produced by new sealing processes developed in 1939 by Montana Highway Department.

CANADA. Alaska Highway, A. Dixon. *Eng. J.*, vol. 23, no. 6, June 1940, pp. 263–264. Outline of Canadian project for construction of highway from central British Columbia through Yukon to Fairbanks, Alaska.

CONCRETE. Concrete Design, Materials Control and Supply, I. L. Tyler. *Roads & Streets*, vol. 83, no. 6, June 1940, pp. 66–67 and 74. Railroad quarry cooperation to insure adequate stock piles for construction of Pennsylvania Turnpike; stocking of materials; specification requirements; control of materials; mixing water control; batching; test records.

CONSTRUCTION. Paving Procedure and Performance Analyzed, J. D. Paul. *Roads & Streets*, vol. 83, no. 6, June 1940, pp. 46–54. Outline of two typical methods of equipment organization and construction procedure for Pennsylvania Turnpike; construction schedules and material supplies; truck hauling; personnel studies; list of contracts; paving production; curves showing scheduled paving yardage and actual yardage placed; equipment and operating methods on paving contracts; tandem operation of pavers; quantities and unit prices bid.

CRUSHED STONE. Ohio Highway Experience with Crushed Stone, R. R. Litehiser. *Crushed Stone J.*, vol. 15, no. 1, Jan.–Mar. 1940, pp. 25–29. Use of crushed stone has played important part in development of bituminous concrete in Ohio highway program and in portland cement concrete program; tables giving summary of concrete core compressive strengths and transverse strengths of coarse aggregates for 1935, 1936, 1937, and 1938.

CURVES. Highway Transition-Curves: New Basis for Design, H. A. Warren. *Instn. Civ. Engrs.—J.*, no. 7, June 1940, pp. 373–382. Theory of author's original highway transition curve based on limitation to length arising from real accelerations, in contradistinction to rates of gain of these accelerations of arbitrary value; numerical examples.

DESIGN. Caracteristiques auxquelles doit etre subordonne le trace des routes en fonction de la vitesse des automobiles, Marce. *Annales des Ponts et Chaussees*, vol. 109, no. 11, Nov. 1939, pp. 449–475. Theoretical mathematical discussion of factors in design of modern highways based on automobile speed, with special reference to curves, braking distance, and visibility; method of design of longitudinal vertical curves; numerical examples.

DESIGN. Construction Design Chart LIV—Loose Stone for Highway Surfacing, J. R. Griffith. *Western Construction News*, vol. 15, no. 6, June 1940, p. 217. Alignment chart for figuring quantity of loose stone or gravel required for various widths of highway surfacing.

DESIGN. Random Notes on Road Design, H. Criswell. *Surveyor*, vol. 97, nos. 2523 and 2524, May 31, 1940, pp. 471–472, and June 7, pp. 487–488. Discussion of design of horizontal and vertical highway curves; definition of rate of change of gradient; gradients; approaches to roundabouts; elimination of "broken-back" curves; general observations on cross-sections; illustrative numerical examples.

EXPRESSWAYS, ARGENTINE. Buenos Aires Builds Superhighway, F. Holoubek. *Better Roads*, vol. 10, no. 6, June 1940, pp. 28–29. Features of General Paz Avenue expressway in Buenos Aires, Argentine, 16 miles long and 328 ft wide, for traffic speeds of 75 mph.

EXPRESSWAYS, PORTLAND, ORE. $4,000,000 Arterial at Portland. *Western Construction News*, vol. 15, no. 6, June 1940, pp. 200–201. Outline of project for construction of $4,000,000 modern six-lane arterial highway along Willamette River water front in Portland, Ore., to provide improved access to business areas of city from both north and south highway approaches, as well as to give high speed boulevard for through traffic.

INTERSECTIONS. Toronto's Western Approach, V. S. Murray. *Roads & Bridges*, vol. 78, no. 5, May 1940, pp. 14–17, 88, and 91. Description of highway grade-separation scheme west of Toronto which will provide express highway entrance and exit for all traffic to and from points west of Toronto.

JOINTS. Some Experiences with Expansion Joints in Concrete Pavements, A. P. Anderson. *Pub. Roads*, vol. 21, no. 3, May 1940, pp. 57–61. Review of experience with rubber and rubber compounds used as filler or seal by Division of Construction of U.S. Public Roads Administration; sponge-rubber fillers; bond between joint filler and pavement; preformed rubber caps; seals containing bituminous materials.

QUEBEC. Quebec's Three-Year Program, E. Gohier. *Roads & Bridges*, vol. 78, no. 5, May 1940, pp. 18–21, 91–92, and 94. Outline of $60,000,000 program of highway construction to be carried out within next three years; program of highway rearrangement near Montreal; proposed grade-separation and intersectional development; typical cross sections of two-lane, three-lane, and three-lane-convertible highways.

ROAD MACHINERY, MAINTENANCE AND REPAIR. How Counties Maintain Highway Equipment. *Pub. Works*, vol. 71, no. 5, May 1940, pp. 24 and 26. Results of annual survey of procedures of 790 counties in operation, maintenance, and renewal of highway equipment; inspection and overhaul of equipment; central garages and mobile repair trucks.

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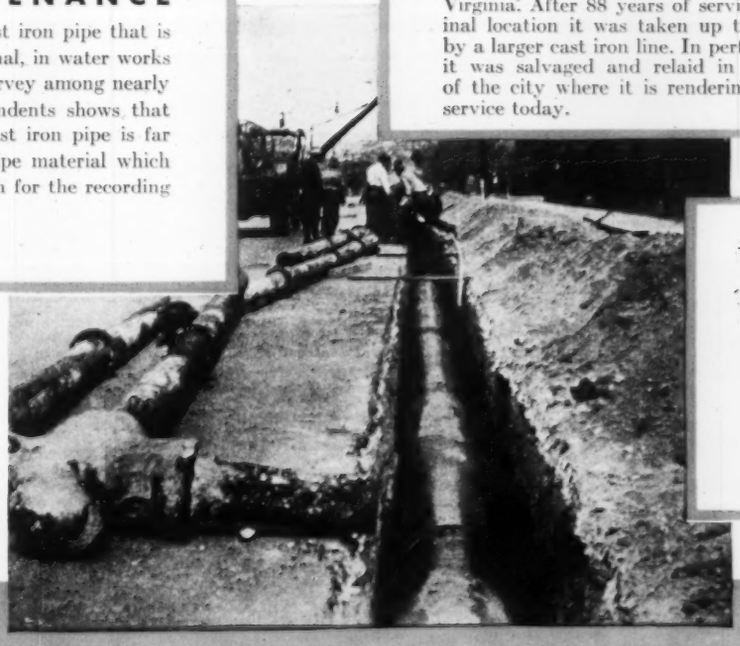

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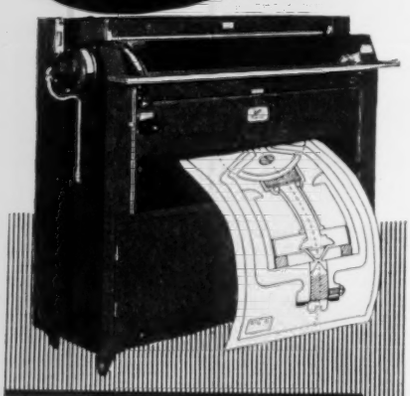

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ROADSIDE IMPROVEMENT. Fighting Highway Erosion, A. M. Davis. *Better Roads*, vol. 10, no. 4. Apr. 1940, pp. 17–19 and 31. Discussion of methods of prevention of roadside erosion by planting of soil-fixing vegetation and other measures.

SEWERAGE AND SEWAGE DISPOSAL

BIOCHEMICAL OXYGEN DEMAND. Analysis of Biochemical Oxygen Demand Curve, H. A. Thomas, Jr. *Sewage Works J.*, vol. 12, no. 3, May 1940, pp. 504–512. Outline of method of computing lag period and probable errors of constants in equation of unimolecular reaction; applying this method to B.O.D. test demonstrating that initial seeding may change shape of oxygen demand curve. Bibliography.

COAGULATION. Use of Copperas-Sodium Silicate as Sewage Coagulant, E. Hurwitz and F. M. Williamson. *Sewage Works J.*, vol. 12, no. 3, May 1940, pp. 562–570. Experimental investigation of use of chemicals as additional treatment for sewage at West Side Works of Sanitary District of Chicago, showing that combination of copperas and sodium silicate gives strikingly efficient results at comparatively low cost; preparation of sodium silicate solutions; theories of mechanism of reaction; cost of treatment; use of steel pickling liquor. Bibliography.

DISPOSAL PLANTS, DALLAS, TEX. New Sewage Treatment Plant of Dallas, R. M. Dixon. *Water Works & Sewerage*, vol. 87, no. 6, June 1940, pp. 245–255. Design and construction of new 32-mgd sewage disposal plant of Dallas, Tex., serving population equivalent of 500,000, costing $1,535,000; selecting method of treatment; grit removal; grease removal and odor control; metering and flow control; trickling filters; recirculation of effluent; operation and control; landscaping and grading.

DISPOSAL PLANTS, OPERATION. Sewage Treatment Plant Tests, and Results. *Mun. Sanitation*, vol. 11, no. 5, May 1940, pp. 251–254. Practical discussion by superintendents of sewage disposal plants of routine tests in sewage plant operation, including tests of raw sewage, effluents, sludge, screenings, and of diluting stream.

FILTRATION. Production of Carbon Dioxide in Biological Filter Bed, H. Wilson and J. A. McLachlan. *Sewage Works J.*, vol. 12, no. 3, May 1940, pp. 557–561. Results of carbon balance study on filter bed process showing that carbonaceous matter is oxidized to carbon dioxide to much greater extent in filter beds than in activated sludge process. Bibliography.

GREAT BRITAIN. Sewage Disposal at Darlington, H. Elders and A. Brown. *Civ. Eng.* (London), vol. 35, no. 406, Apr. 1940, pp. 98–101. Description of new sewage disposal works now under construction at Darlington, England, having capacity of about 2.5 mgd, estimated to cost about £ 85,000; details of sedimentation tanks, stormwater tanks, sludge drying beds, humus tanks, and pump house.

HIGHWAY, PENNSYLVANIA. Selection of Bridge Structures for Economy, R. F. Graef. *Roads & Streets*, vol. 83, no. 6, June 1940, pp. 58–60. Comparative study of types of short-span highway bridges adopted on Pennsylvania Turnpike for highway and railroad crossings; typical drainage; overhead and underpass designs; special designs for stream and road crossings.

INDUSTRIAL WASTE. Packing House Waste Treatment, L. R. Howson. *Water Works & Sewerage*, vol. 87, no. 5, May 1940, pp. 217–222. Description of 0.7-mgd plant for treating wastes of Armour and Company packing plant at West Fargo, N.Dak., placed in operation in March 1938; fine screens; grease flotation; flocculation compartment; primary filters; winter operation; final filters.

NEW YORK CITY. Sewage Disposal for New York City, R. H. Gould. *Mun. Engrs. J.*, vol. 25; 3d quarterly issue 1939, pp. 108–126 (discussion) 126–134, supp. plate. Discussion of recent development of sewage disposal system of New York City, with special reference to new sewage disposal plants.

ODOR CONTROL. In Hot Weather, How Do You Control Odors at Your Sewage-Disposal Plant? *Water & Sewage*, vol. 78, no. 6, June 1940, pp. 23 and 57–59. Discussion by Canadian engineers of methods of control of sewage disposal odors in hot weather.

PLANTS, DESIGN. Solving Design Problems, R. Eliassen. *Mun. Sanitation*, vol. 11, nos. 4,5, and 6, Apr. 1940, pp. 187–188; May, pp. 234–238; and June, pp. 288–290. Principles of design of settling tanks for sewage disposal plants; outline of various methods of digestion tank design; nomographic charts for simple solution of practical problems; applying principles suggested by committee; principles of design of trickling filters; nomographic charts for solution of design problems; numerical examples. Bibliography.

PLANTS, LANDSCAPING. Landscape Treatment at Sewage Works, C. B. Tilton. *Mun. Sanitation*, vol. 11, no. 5, May 1940, pp. 228–231. Information on suitable planting of trees, shrubs, and grasses for grounds of sewage disposal plants.

SANITARY ENGINEERING EDUCATION. Short School Instruction for Superintendents and Operators, W. A. Hardenbergh. *Pub. Works*, vol. 71, no. 4, Apr. 1940, pp. 13–15 and 42. Organization and operation of Georgia short school for supplementary instruction of superintendents and operators of water works and sewage disposal systems.

SEDIMENTATION. Some Observations on Sewage Sedimentation, N. C. Wittwer. *Sewage Works J.*, vol. 12, no. 3, May 1940, pp. 513–526. Study of requirements for primary sedimentation of raw sewage and correlation of strength of raw sewage with settling tank performance, based on data obtained from records of Rahway Sewage Treatment Plant, Rahway, N. J.; sewage flows vs. settling efficiencies.

SEWER TUNNELS, CONSTRUCTION. Building Big Sewer in Bad Ground, W. B. Fowler. *Eng. News-Rec.*, vol. 124, no. 21, May 23, 1940, pp. 56–59. Use of compressed air-tunneling methods with pressures ranging from 2 to 28 lb per sq in. for construction of 27-mgd horseshoe reinforced concrete intercepting sewer tunnel, about 14,000 ft long, paralleling river front at Memphis, Tenn.; features of steel braces and liners.

SEWERS, BACKWATER GATES. Hydraulic Model Studies Solve Backwater Gate Design, G. E. Hubbell. *Eng. News-Rec.*, vol. 124, no. 19, May 9, 1940, pp. 73–74. Results of hydraulic tests of 1/24 models for economic design of 6-chamber backwater structures, 75 ft wide, above river outlet of sewer system of Detroit, Mich.; data obtained from model test with flow of 3,000 cu ft per sec; revisions in design.

SEWERS, CONSTRUCTION. Relief-Sewer Construction in Ottawa, J. H. Irvine. *Water & Sewage*, vol. 78, no. 6, June 1940, pp. 7–10, 42, and 44–47. Review of development of Ottawa sewer system since 1900; description of old system; intensity and duration of rainfall at Ottawa; studies of drainage; description of relief sewers built since 1930 at cost of $2,500,000.

SEWERS, STORM. Die Bestimmung von richtigen Fliesszeiten in den Entwaesserungsnetzen, B. Bayerle. *Gesundheits-Ingenieur*, vol. 63, no. 6, Feb. 10, 1940, pp. 65–70. Theoretical mathematical discussion of hydraulics of storm sewers; formulas for correct determination of time of inflow from highest point of sewer line to given point in sewer system for given rainfall conditions; graphical method of drainage area curves.

SLUDGE. Methods of Sludge Disposal. *Mun. Sanitation*, vol. 11, no. 6, June 1940, pp. 295–298. Practical discussion by sewage disposal plant superintendents and chemists of problem of sewage sludge disposal; utilization and marketing of sewage sludge.

SLUDGE. Sludge Disposal and Power Generation, W. A. Dundas. *Western Soc. Engrs.—J.*, vol. 45, no. 1, Feb. 1940, pp. 19–30. Review of practice developed at Southwest Sewage Treatment Works of Chicago Sanitary District for disposal of sewage sludge by drying and incineration; utilization of sludge for generation of steam and electric power; features of equipment and processes for generation of power from sewage sludge; chlorination equipment.

SLUDGE. Some Considerations to Question of Sludge Density, G. J. Wiest. *Water Works & Sewerage*, vol. 87, no. 5, May 1940, p. 216. Discussion of graph showing relation of sewage sludge volume to solids content variations.

SLUDGE. Use of Sewage Sludge as Fertilizer and Soil Conditioner, L. W. Van Kleeck. *Pub. Works*, vol. 71, no. 6, June 1940, pp. 20–22. Types of digested sludge; data on fertilizing value of sludges of various types; amounts to be used; interpretation of chemical analyses; methods of applying digested sludge and hygienic considerations; fortifying digested sludge with chemicals.

UNITED STATES. Trend of Practice in Sewage Treatment and Sludge Disposal at Recent Large Plants, A. L. Fales, *Water & Sewage*, vol. 78, no. 5, May 1940, pp. 7–15 and 55–58. Review of trends in sewage-disposal practice at 7 large plants recently constructed in United States; extent of treatment; screens and comminutors; sludge and scum removal; disposal of sludge; odor control. Bibliography.

WATER POLLUTION, INDIANA. Stream Pollution Control Advances in Indiana, B. A. Poole, *Mun. Sanitation*, vol. 11, no. 6, June 1940, pp. 282–284. Statistical data on and review of progress in construction of sewage disposal plants resulting in control of stream pollution in Indiana; review of legislation and administrative action.

STRUCTURAL ENGINEERING

ARCHES, CONCRETE. Movable Centering for Reinforced-Concrete Arches, V. Cherre. *Engineering*, vol. 149 no. 3872, Mar. 29, 1940, pp. 321–322. Method that greatly lowers cost and speeds up construction of arches is employment of movable centering, consisting of falsework set up on trestles; trestles are supported on carriages running on narrow gage lines and consist of series of bowstring trusses held together by horizontal and vertical bracing.

BEAMS, CONCRETE. Effect of Impact on Reinforced Concrete Beams, T. D. Mylrea. *Am. Concrete Inst.—J.*, vol. 11, no. 6, June 1940, pp. 581–594. Discussion of impact resistance of rein-

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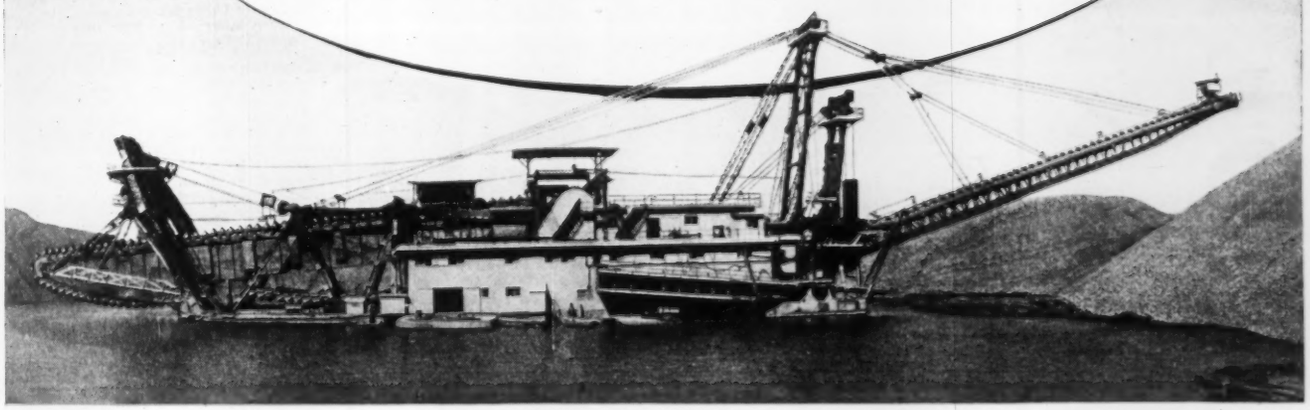

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forcing steels investigated by means of tests on 10 by 16-in. beams, of span of 8 ft, reinforced with varying amounts of steels of different grades; Izod tests.

BEAMS, CONCRETE. Nomograms for Design of Reinforced Concrete Beams, W. G. Sutton and J. R. Kerrich. *Structural Engr.*, vol. 18, no. 5, May 1940, pp. 597–603. Construction of three alignment charts for solving formulas for design of reinforced concrete beams on basis of straight-line theory; numerical examples.

BEAMS, DESIGN. Load Ranges for Simple Beams, C. O. Harris. *Western Soc. Engrs.—J.*, vol. 45, no. 1, Feb. 1940, pp. 39–43. Theoretical mathematical discussion of boundaries of load ranges in which design of beam is governed by shear, bending moments, or deflections.

COLUMNS, CONCRETE. Charts for Concrete Column Design, R. B. H. Begg. *Va. Polytechnic Inst.—Eng. Experiment Station—Bul., No. 40, No. 33, No. 1*, Nov. 1939, 17 pp. Collection of alinement charts for approximate determination of stresses in reinforced concrete columns without use of long algebraic formulas; numerical examples.

FLOORS. Timberless Floors and Flat Roofs. *Roy. Inst. Brit. Architects—J.*, vol. 47, 3d series, no. 6, Apr. 15, 1940, pp. 146–151. Features of several patented European and American types of floors built of concrete, steel, or clay tiles.

FLOORS, DESIGN. Timberless Floors and Flat Roofs. *Surveyor*, vol. 97, nos. 2517 and 2518, Apr. 19, 1940, pp. 353–355, and Apr. 26, pp. 375–377. Note from Information Bureau of Building Research Station of Great Britain giving features of numerous patented European designs of floor decks and slab roofs, built of steel, reinforced concrete, and hollow tile.

GARAGES, DESIGN. Timber Arches for Buildings, A. S. Friedman. *Eng. News-Rec.*, vol. 124, no. 25, June 20, 1940, p. 55. Description of five state garages in Wisconsin featuring glued laminated timber roof arches of 80-ft span supported by reinforced concrete buttresses 9 ft high.

JOINTS, BOLTED. Strain-Bearing Panel System, E. Schaefer. *Steel*, vol. 106, no. 9, Feb. 26, 1940, pp. 52, 54, and 76. Details of Permagrip fastening method of making stressed skin structures, which has tension applied by wedge action as parts are tightened during assembly; system is applicable to auto, truck, and railroad car bodies, airplanes, tanks, and boilers.

MODELS. Models in Engineering, R. B. Whittington and F. J. Sanger. *Eng. Soc. China—Paper No. I.C.E. 1*, 1939, 107 pp. Collection of papers including following: Structural Models; Hydraulic Models; Aerodynamics and Acoustics; Naval Architecture; Soil Mechanics; Geometrical Models; Structures; Hydraulics (General); Hydraulics (Tidal Models).

ROOFS, DESIGN. Design of Valley and Hip Rafters, C. N. Dirlam. *Bldg. Standards Monthly*, vol. 9, no. 4, Apr. 1940, pp. 5–7. Diagrams and charts for determination of proper size for valley or hip rafter; allowable total and reaction on Douglas fir beams.

STAINLESS STEEL, ARCHITECTURAL. Stainless Steel Comes of Age in Architecture, H. H. Harris. *Metal Progress*, vol. 37, no. 5, May 1940, pp. 537–540, 586, and 590. General review, with descriptions of some examples.

STATICALLY INDETERMINATE STRUCTURES, DESIGN. De deux méthodes et applications de calculs des systèmes hyperstatiques plans, A. Birguet. *Travaux*, vol. 24, nos. 87 and 88, Mar. 1940, pp. 87–94, and Apr. pp. 104–108. Theoretical mathematical outline of two methods of design of plane statically indeterminate structures; general theory of design of statically indeterminate framed structures.

STRESSES, MEASUREMENT. Stress-Strain Analysis. *Product Eng.*, vol. 11, no. 6, June 1940, pp. 266–268. Determination of stresses in loaded parts by measuring width of crack formations in brittle lacquer-coated specimens.

WALLS, MASONRY. Full Mortar Joints Most Important to Prevent Leaky Walls, L. A. Palmer. *Brick & Clay Rec.*, vol. 96, no. 4, Apr. 1940, pp. 50 and 52. Mortar strength is not most essential property for building dry walls; author offers suggestions as to how to get tight wall.

SURVEYING

HYDROGRAPHIC SURVEYING, BERING SEA. Bering Sea Survey, E. W. Eickelberg. *Field Engrs. Bul.*, no. 13, Dec. 1939, pp. 73–79. Summary of experience in charting of Bering Sea area; camp parties; radio-acoustic ranging.

TRAFFIC CONTROL

CURBS. Chicago Builds Convertible Roadway, O. K. Jelinek. *Eng. News-Rec.*, vol. 124, no. 23, June 6, 1940, pp. 58–61. Use of roadway dividing curbs that can be elevated or retracted by hydraulic-power system, which is electrically actuated, on new 8-lane access road to Chicago business district, providing traffic with six in and two out lanes, or two in and six out lanes, or four lanes each way; hydraulic jacks and springs for raising and lowering curb and curb-lighting equipment.

PENNSYLVANIA TURNPIKE. Signing Turnpike, G. R. Britton. *Roads & Streets*, vol. 83, no. 6, June 1940, pp. 62 and 64. Results of letter legibility tests for design of signs on Pennsylvania Turnpike; interchange signs; tunnel approach signs.

TUNNELS

COAL MINES AND MINING. Driving Drift through Sand Beds, H. E. Tyson. *Iron & Coal Trades Rev.*, vol. 140, no. 3754, Feb. 9, 1940, pp. 261–262. Record of operations in driving drift from surface, through beds of sand, to low main seam. From paper before Nat. Assn. Colliery Mgrs.

CONSTRUCTION. Making Every Minute Count in Tunnel Driving, R. S. Byers. *Compressed Air Mag.*, vol. 45, no. 4, Apr. 1940, pp. 6116–6122. Features of equipment and practice in driving one of 3 main pressure tunnels to link Rondout Reservoir with Hill View Reservoir, just outside of New York City; 3,100 ft of tunnel about 17½ ft in diameter driven in 31 days with two headings from single shaft; typical drill round; mechanical mucking; use of "cherry picker" for lifting empty cars for transfer to end of train nearest heading without switching.

CONSTRUCTION. Twelve Contractors Drive 85-Mile Rock Tunnel for Delaware Aqueduct. *Construction Methods*, vol. 22, no. 5, May 1940, pp. 46–49, 88–90, and 92–94. Progress report on construction of 31 shafts and 85 miles of Delaware Aqueduct tunnel for water supply of New York City; experience with various types of tunnel driving equipment and explosives.

CONSTRUCTION, ACCIDENT PREVENTION. 85 Miles of Hazard. *Nat. Safety News*, vol. 41, no. 6, June 1940, pp. 20–21. Safety and health measures taken by New York State Department of Labor, to protect 6,000 workers on Delaware Aqueduct, being blasted from Hill View Reservoir near Yonkers to upper reaches of Delaware River, to assure adequate supply of pure water for New York City's needs.

DAM CONSTRUCTION, DIVERSION TUNNELS. Safety Diversion Tunnel and Shafts, P. G. Van Sickle. *Reclamation Era*, vol. 30, no. 5, May 1940, pp. 131–135 and 143. Methods and equipment used in construction of 18-ft circular concrete-lined diversion tunnel, 1,575 ft long, for construction of Green Mountain earth and rock fill dam near Kremmling, Colo.; mucking and blasting; accident statistics.

MINES AND MINING. Carlton Drainage Tunnel, Cripple Creek, Colorado, A. H. Bebee. *Mines Mag.*, vol. 30, no. 5, May 1940, pp. 245–248, 251, and 276. Progress notes on driving of 32,000-ft tunnel, to provide 1,100 ft of additional permanent drainage for Cripple Creek district; similar descriptions previously indexed from various sources.

PENNSYLVANIA. Tunneling on Turnpike. *Eng. News Rec.*, vol. 124, no. 23, June 6, 1940, pp. 48–53. Methods used in driving seven tunnels, totaling 6.5 miles, to carry Pennsylvania Turnpike superhighway through Allegheny Mountains; design features; ventilation of roadways; provision for resisting acid-seepage waters; handling high rock falls in old headings; use of large drill carriages and shovels; muck haulage by truck and tractor wagons.

RAILROAD CONSTRUCTION, CALIFORNIA. Modern Railroad Construction for 30-Mile Relocation at Shasta Dam. *Western Construction News*, vol. 15, no. 5, May 1940, pp. 169–173. Report on construction of some 35-miles of relocated Southern Pacific line at Shasta Dam in northern California, including 12 tunnels and 8 major bridges; use of latest earthwork methods.

SUBWAY CONSTRUCTION, NEW YORK CITY. Construction of Sixth Avenue Subway, B. Houghtaling. *Mun. Engrs. J.*, vol. 26, first quarterly issue 1940, pp. 23–47, (discussion) 47–64. Report on construction, 2¼ miles long, at cost of $60,000,000; restoration of subsurface utilities; stations; by-passing of gas mains; underpinning of elevated columns and buildings; excavation; decking; construction of two tracks by cast-iron lined tunnel by use of shield under compressed air; construction of rock tunnels; reconstruction of Hudson and Manhattan Railroad.

VEHICULAR, NETHERLANDS. La construction du tunnel sous la Meuse, a Rotterdam, C. Fritzlin. *Technique des Travaux*, vol. 16, no. 3, Mar. 1940, pp. 115–138. Article on design and construction of Rotterdam, Netherlands, vehicular tunnel under Meuse River; details of ventilating plant; cost data.

WASHINGTON. Snow Lake Tunnel, C. J. Nielsen. *Reclamation Era*, vol. 30, no. 3, Mar. 1940, pp. 72–76. Driving of 2,000-ft rock tunnel, 5 by 7 ft in cross section, tapping mountain lake 150 ft below its surface, in order to supply cold water for fish hatchery at Leavenworth, Wash.; transportation of heavy valves over rock trails.

WATER SUPPLY, CONSTRUCTION. Rock Drilling Practice Maintains Record Speed in Stanislaus Tunnel, G. B. Thacher. *Construction Methods*, vol. 22, no. 6, June 1940, pp. 62–65, 102–104, and 106–108. Construction of Stanislaus Tunnel in central California, by Pacific Gas

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and Electric Company; equipment and methods used in driving 11 miles of 9½ by 11¼-ft unlined, hard-rock tunnel with average daily advance of 38.35 ft per heading crew; accident costs in percentage of total labor costs; features of job designed drill carriage; drill maintenance and repair.

WATER PIPE LINES

CORROSION. Neuere Ansichten ueber die Aggressivitaet des Wassers, L. W. Hasse. *Gesundheits-Ingenieur*, vol. 63, no. 9, Mar. 2, 1940, pp. 104–107. Review of recent American, German, and Swiss studies of corrosive effect of waters of various chemical compositions and hydrogen-ion concentrations pointing out importance of maintaining sufficient oxygen content in water. Bibliography.

LEAKAGE. How to Discover Leaks and Locate Water Wastage. *Pub. Works*, vol. 71, no. 4, Apr. 1940, pp. 28–32, 34, 37–38, and 40. Review of modern practice for determining amount of wastage in supply lines and distribution systems, and methods and equipment for locating sources of leaks and losses; leakage control practice in Reading, Pa.

LEAKAGE. Water Waste Prevention Methods. A. M. Moon. *Surveyor*, vol. 97, no. 2515, Apr. 5, 1940, pp. 311–313. Review of British experience with leakage and other losses from pipe lines; source of loss; vibration effects on mains; precautions against waste; detecting waste by waste water meter; waste detection routine; stopcock inspection for waste.

LINING. Lining Cast-Iron Mains in Position with Cement Mortar, J. E. Gibson. *Am. Water Works Assn.—J.*, vol. 32, no. 5, May 1940, pp. 819–837; see also *Water Works & Sewerage*, vol. 87, no. 5, May 1940, pp. 223–230. Experience of water department of Charleston, S.C., with experimental lining of about 2½ miles of 4-, 6-, and 8-in. water mains; process and equipment for cleaning and lining; mortar tests; cost of project; use of graded or kiln dried sand; permanency of lining. Bibliography.

SUBAQUEOUS. Main Laid on Harbour Bed. *Water & Water Eng.*, vol. 42, no. 525, June 1940, pp. 222–224. Methods and equipment used in laying 18-in. water main across Bristol Harbor, England, where it is 187 ft wide and 30 ft deep; diagram showing how barges carrying sections of main were maneuvered to permit final joints to be made.

WATER RESOURCES

GREAT BRITAIN. London's Water Supply. *Engineer*, vol. 169, no. 4396, Apr. 12, 1940, pp. 344–347. Illustrated description of new laboratories and work of laboratories; works efficiency; river Thames as source of potable water; rainfall and flow. Excerpts from Annual Report of Metropolitan Water Board for year ending Dec. 31, 1938.

SURFACE, RIO GRANDE. Flow of Rio Grande and Tributary Contributions. *Int. Boundary Commission U.S. & Mexico—Water Bul. No. 8*, 80 pp. Compilation of stream discharges and related data relative to cooperative determination of flow of international portion of Rio Grande; general hydrologic conditions for 1938; discharge records; sources of river flow; quality of water; floods; evaporation and rainfall; irrigated areas.

UNDERGROUND, PENNSYLVANIA. Ground Water in North-Central Pennsylvania, S. W. Lohman and E. W. Lohr. *Pa. Geol. Survey—Bul. W6*, 1939, 219 pp., figs., tables, supp. plates. Report on geography, geology, and ground-water resources of area covering 7,221 sq miles in north-central Pennsylvania, including 8 counties of Bradford, Cameron, Elk, Lycoming, McKean, Potter, Sullivan, and Tioga; quality of water; water bearing formations; county descriptions.

WATER TREATMENT

ALGAE CONTROL. Algae Control, J. B. Baty. *Water & Sewage*, vol. 78, no. 6, June 1940, pp. 20 and 48. Elementary exposition of problems of algae control in surface waters and reservoirs of water works; causes of troubles; quantity of chemicals required to destroy some of species of microscopic organisms; limiting dosage of copper sulfate to protect fish.

ALGAE CONTROL. Use of "Benoclor-3" in Potable Water Supplies, M. M. Gibbons. *Water Works & Sewerage*, vol. 87, no. 5, May 1940, pp. 231–236. Report on large-scale field tests at Echo Lake, Westfield, N.J., on effect of liquid chlorinated benzene preparation, "Benoclor-3," used for algae control, on odor and taste of water treated with it; effect of outdoor storage and aeration; disappearance of "Benoclor" odors during storage.

ANALYSIS, CANADA. Investigating Quality of Canadian Waters, H. A. Leverin. *Eng. & Contract Rec.*, vol. 35, no. 14, Apr. 3, 1940, pp. 31–34. Results of country-wide study, by Department of Mines and Resources of Canada, of quality of Canadian water supplies; hardness map; standardization of methods of analysis.

MILWAUKEE, WIS. Milwaukee's Water Purification Plant, J. P. Schwada. *Water Works & Sewerage*, vol. 87 nos. 4 and 5, Apr. 1940, pp. 137–145 and May, pp. 195–200. Detailed description of new 200-mgd mechanical rapid sand filtration plant of Milwaukee, Wis.; water flow through plant; pump building; chemical feed facilities; coagulation basins and flocculators; filter building and appurtenances; wash water system; metering; laboratories; architectural and structural features; landscaping.

OZONE. Treatment of Water by Ozone, M. T. B. Whitson. *Surveyor*, vol. 97, no. 2513, Mar. 22, 1940, pp. 279–280. Development of ozone treatment of water in France; results of recent British experiments with ozonization of water; cost data. Before Instn. Civ. Engrs.

WATER WORKS ENGINEERING

ANTI-AIRCRAFT PROTECTION FOR WATER SUPPLY. War Measures, J. S. Trevor. *Water Works & Sewerage*, vol. 87, no. 6, June 1940, pp. 256–259. Review of measures adopted in Great Britain for war-time protection of water and sewerage services; sandbag protection; camouflage; maintenance of supplies in emergency; supplementary sources of water supply; dangers of burst sewers in London; repairing damaged mains.

GUATEMALA. Old Spanish Aqueducts Replaced in Guatemala City, R. Hancock. *Water Works Eng.*, vol. 93, no. 13, June 19, 1940, pp. 806–807. Description of new water works of Guatemala City, including dam 98 ft high and 73,000 ft of 18- and 24-in. cast iron pipes, also water treatment plant and distribution reservoirs.

MAINTENANCE AND REPAIR. Water Practices of Atlanta, Ga., N. N. Wolpert. *Water Works Eng.*, vol. 93, no. 12, June 5, 1940, pp. 740–746. Description of maintenance and repair methods and tools developed for frost troubles; installation of mains; pipe extensions; distribution record cards; valve practices; meter boxes; cleaning meters; hot water damage; special truck bodies; cutting large pipe; tests for pressure; flushing of dead ends.

SAN FRANCISCO, CALIF. Water Supply System of San Francisco, N. A. Eckart. *Am. Water Works Assn.—J.*, vol. 32, no. 5, May 1940, pp. 751–794. History and description of water supply system, including data on dams, reservoirs, pipe lines, filtration galleries, etc.; coast range tunnels; city distribution system; supply for Treasure Island of Golden Gate International Exposition; pressure districts; pumping stations; characteristics and quality of water; sanitary control.

SUPPLY, UNITED STATES. Water and Government, P. V. McNutt. *Am. Water Works Assn.—J.*, vol. 32, no. 5, May 1940, pp. 719–728. Non-technical address by U.S. Federal Security Administrator discussing drinking water standards, federal research, Ohio River compact, vocational education, emergency services, etc.

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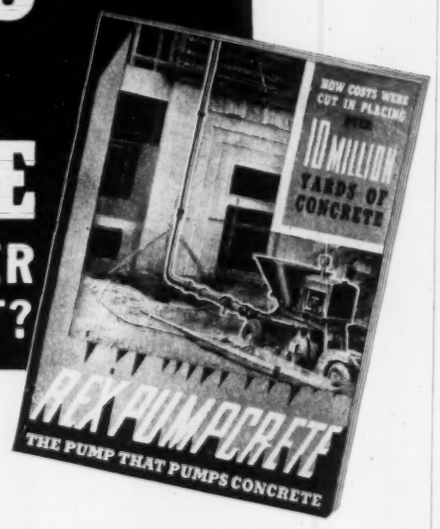

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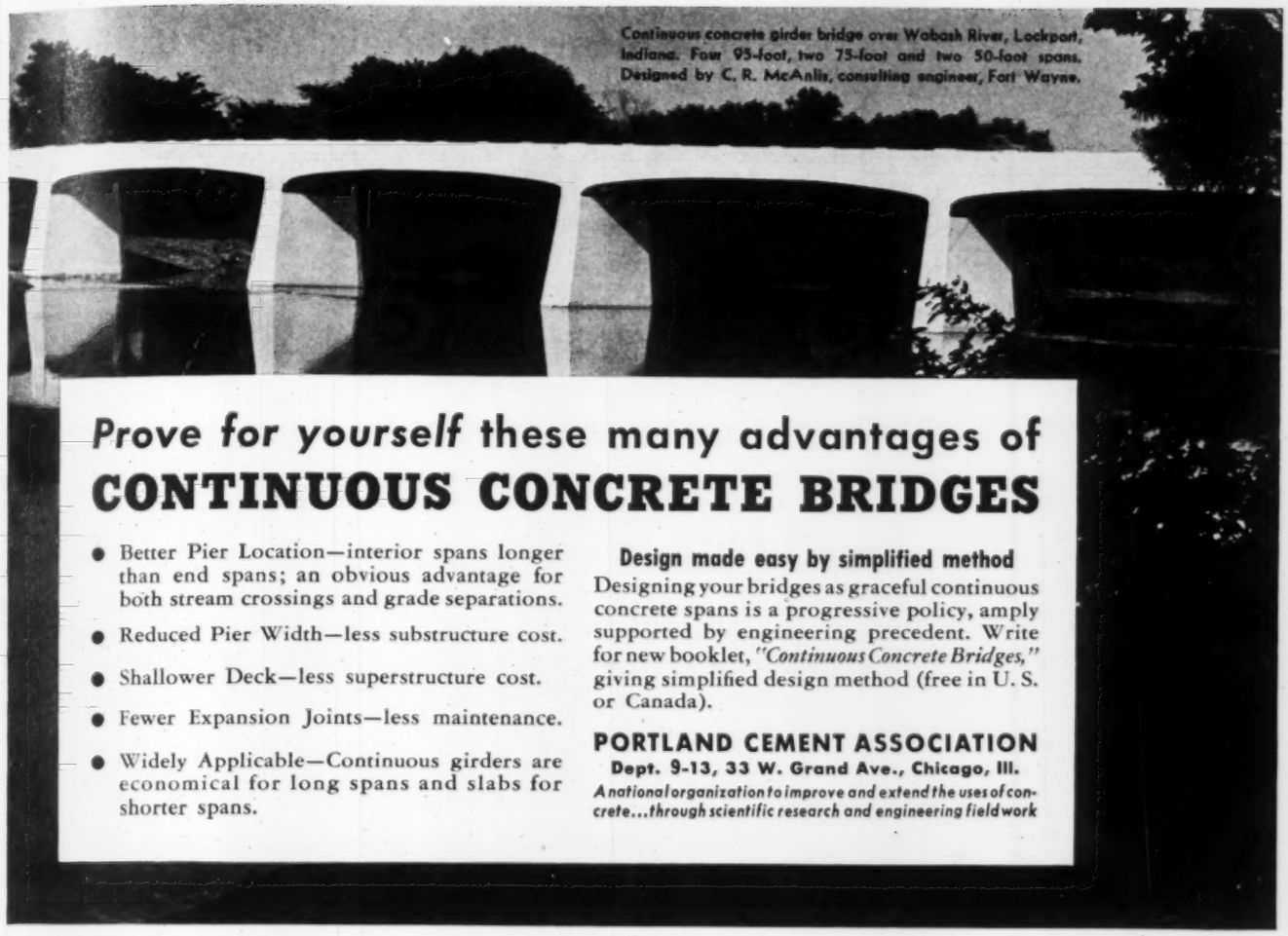
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Chicago Bridge & Iron Co.

BLOWER PIPE, STEEL, FOR VENTILATION PURPOSES
Lock Joint Pipe Co.

BOOKS, TECHNICAL
Macmillan Co.

BORINGS, TEST
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

BRIDGES
American Bridge Co.
Bethlehem Steel Co.

BRIDGE PLANKS, MINERAL SURFACED ASPHALT
Johns-Manville Corp.

BUILDINGS, STEEL
American Bridge Co.
Bethlehem Steel Co.

CAISSONS
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

CEMENT, HIGH-EARLY-STRENGTH PORTLAND
Lone Star Cement Corp.

CEMENT, PORTLAND
Lone Star Cement Corp.
Portland Cement Assn.

CHEMICAL FEEDERS, WATER AND SEWERAGE
Proportioneers, Inc.

CLOTH PRINTS
Ozalid Corp.

COLD MIX
Texas Co.

COLD ROLLED SHEETS
Weirton Steel Co.

COLD ROLLED STRIP
Weirton Steel Co.

CONCRETE ADMIXTURES
Johns-Manville Corp.

CONCRETE FORM ANCHORS, WOOD OR STEEL FORMS, LIGHT AND HEAVY CONSTRUCTION
Richmond Screw Anchor, Inc.

CONCRETE MIXERS
Chain Belt Co.

CONCRETE PUMPS
Chain Belt Co.

CONCRETE REINFORCEMENT
Bethlehem Steel Co.
Carnegie-Illinois Steel Corp.

CONDENSER AUXILIARIES
Worthington Pump and Machinery Corp.

CONSTRUCTION AIR TOOLS
Worthington Pump and Machinery Corp.

CONTRACTORS
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Spencer, White & Prentis, Inc.

CONVEYORS
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CORRUGATED SHEETS, ALUMINUM
Aluminum Co. of America

CORRUGATED SHEETS, ASBESTOS-CEMENT
Johns-Manville Corp.

CULVERTS, ASBESTOS-CEMENT
Johns-Manville Corp.

CULVERTS, CAST IRON
Cast Iron Pipe Research Assn.
U. S. Pipe & Foundry Co.

CULVERTS, REINFORCED CONCRETE
Lock Joint Pipe Co.

DRAFTING MACHINES
Keuffel & Esser Co.

DRAFTING (WHITEPRINTS)
Ozalid Corp.

DRAINS, REINFORCED CONCRETE
Lock Joint Pipe Co.

DRY DEVELOPED PRINTS
Ozalid Corp.

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ENGINES, STATIONARY, DIESEL AND GAS
Caterpillar Tractor Co.
Worthington Pump and Machinery Corp.

ENGINEERS
Raymond Concrete Pile Co.
Spencer, White & Prentis, Inc.

EXPANSION JOINTS, ASPHALT OR CORK
Johns-Manville Corp.

FEEDER PUMPS, WATER AND SEWERAGE
Proportioneers, Inc.

FEEDWATER HEATERS
Worthington Pump and Machinery Corp.

FLOORING, ALUMINUM
Aluminum Co. of America

FLOORING, ASPHALT TILE
Johns-Manville Corp.

FLOORING, STEEL
Carnegie-Illinois Steel Corp.

FOIL PRINTS
Ozalid Corp.

FORM CLAMPS, CONCRETE WALL CONSTRUCTION
Richmond Screw Anchor Co., Inc.

FORM TIES, CONCRETE WALL CONSTRUCTION
Richmond Screw Anchor Co., Inc.

FOUNDATIONS
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Spencer, White & Prentis, Inc.

GALVANIZED STEEL SHEETS
Weirton Steel Co.

GASHOLDERS
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Caterpillar Tractor Co.

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Caterpillar Tractor Co.

HANGING DEVICES FOR CONCRETE FORMS
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Commercial Shearing & Stamping Co.

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Weirton Steel Co.

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Weirton Steel Co.

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Continued on page 29

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Equipment, Materials, and Methods

New Developments of Interest, as Reported by Manufacturers

Aluminum Price Cut

IN LINE with the policy of a continuing lower trend in its prices, on August 1, 1940, Aluminum Company of America made another price reduction of one cent a pound for aluminum. On March 25, 1940, the company lowered its price for aluminum from 20 cents to 19 cents a pound. This second change brings the price down to 18 cents.

In discussing the company's price policy last November, Roy A. Hunt, president of the company, said: "The benefits of research and development together with expansion of plants and facilities permit the company to expect lower costs. In line with its expressed policy, it intends to share such economies with consumers."

New Ozalid Whiteprinter

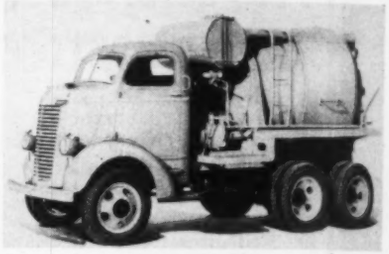
A NEW MEDIUM-PRICED Model "F" Whiteprint machine has been announced by the Ozalid Corp., Johnson City, N.Y. This equipment constitutes a printer and dry-developing unit built into a single, compact machine to turn out dry-developed Ozalid Whiteprints.

Equipped with a new type high-pressure mercury vapor lamp, which uses 40 watts per in. and has an active length of 46 in., the Model "F" will print Ozalid sensitized materials at speeds up to 56 in. per min. The lamp is guaranteed for 1,000 hrs but tests indicate a life of from 1500 to 2500 hrs. An adjustable light shade allows the operator to vary exposure without changing the printing speed. This is claimed to permit a smooth flow of work despite variations in the transparency of tracings.

Cooling of the lamp, which is necessary for uniform light distribution, is provided by a two-stage blower and a specially designed air duct. Maximum lamp efficiency is assured by a reactive type transformer equipped with condensers providing power factor correction to 87.5%. The terminal board on the transformer permits adjustments to correspond with actual line voltage variations from 200 to 240 volts. A Veeder-Root Counter automatically registers operating hours.

New Rex Moto-Mixers

A COMPLETE new line of Rex Moto-Mixers and Moto-Agitators is presented by Chain Belt Co. of Milwaukee, Wis. Designed to make the most of the increased carrying capacity of modern high-speed trucks, these new Rex Moto-Mixers are claimed to promote faster loading, mixing, and greater capacity; enabling users to mix, haul and place more yards per trip.



The dimensions of the new Rex Moto-Mixer drum provide shorter overall lengths and larger drum diameters. Another new feature of the Rex Moto-Mixer is the new no-leak Rex discharge door, maintaining true alignment with the drum at all times, and operated from the mixer or from the ground by a non-creeping hand-wheel.

The new Rex Moto-Mixers offer the Rex twin clutch transmission wherein one lever controls all speeds from high to low and in-between. Optional, at slightly higher cost, are the Rex pneumatic controls which give the driver finger-touch control of drive speeds.

The new sizes are the Rex 2 yd Moto-Mixer with a capacity of 104 cu ft; the 2½ yd with a capacity of 156 cu ft; the Rex 4 yd with a capacity of 208 cu ft; the Rex 5 yd Moto-Mixer with a capacity of 250 cu ft; and the Rex "Metropolitan Special" with a capacity of 270 cu ft.

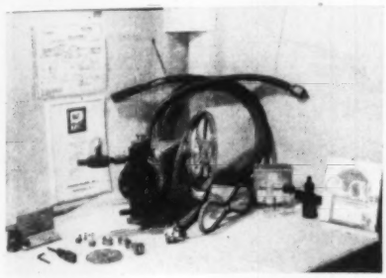
Excavators' "Seeing Eye"

A NEW AUTOMATIC SIGNAL device, designed to forewarn the excavator operator by an audible signal as his bucket approaches hidden underground service pipes or cables, has been announced by Wallace & Tiernan Products, Inc., Belleville, N.J. Known as the WTP Automatic Pipe Anticipator, this new unit is recommended for use in any kind of excavation where pipes and cables may be encountered. It may be attached to any type of excavating or pushing machine. The Anticipator produces a continuous sound which increases in volume as the bucket of the excavator approaches a pipe or cable obstruction.

The manufacturer states that the Pipe Anticipator has been subjected to intensive experimental work by a large utility company, uncovering more than 6,000 live pipes and cables, and excavating 70 to 180 cu yds per machine per day.

A Chlorinator for Under 25 GPM

THE NEED FOR chlorinator protection in the "tiny water supply plant"—private water supplies, camps, wayside restaurants, etc.—is being supplied by Proportioneers, Inc., 9 Codding St., Providence, R.I., with their "Du-Self Chlor-O-Feeder." This "Du-Self Package" for Hypo-Chlorination is a complete unit consisting of an adjustable positive displacement pressure injection hypochlorite feeding pump, with a visible sight feeder, and all necessary pulleys, belts, discharge and suction hoses, valves, hose clamps, essential spare parts, and installation and operating instructions. It is to be driven from the water pump, electric or gas engine power, and can be self installed. Its price of $99.00 places it within the reach of all small private or semi-public water supplies.



While it is unquestionably guaranteed for satisfactory performance on such systems, Proportioneers emphasize the definite limitations in the application of this machine. In water supply service it may only be used for hypochlorite solution, alum or soda ash; in sewage plants only for hypochlorite or ferric chloride. It is not suitable for plants pumping continuously for over 5 hours daily, or for pumping rates of over 25 GPM or over 1,500 GPH. It is also unsuited for drive from shafts of pumps attaining more than 600 RPM or other high speed rotation. It is further limited to injection pressures of under 75 lb per sq in.

Proportioneers have manufactured one production run of these machines to check correct functioning and to establish the shop costs which make possible the low selling price. In this company's opinion this Du-Self Chor-O-Feeder offers to every plant, however small, a safeguard against water borne disease.

Dual Voltage Switch for Arc Welders

THE WILSON WELDER & Metals Co., Inc., 60 E. 42d St., New York, N.Y., has just announced a new Dual Voltage Switch for installation on arc welding machines, when they must be used on either of two line voltages at different times. The new device, known as the Type CH Dual Voltage Switch, can be used on any motor employing AC current, provided the motor and starter are reconnectable for two voltages. Normally, adjusting a motor so that it will operate at a different line voltage requires changes which would take anywhere from $\frac{1}{2}$ to 2 hrs. With the switch installed, this adjustment can be made in less than a minute.

The new Dual Voltage Switch has two main parts—a base which is mounted directly on the machine, and a removable top cover which is held in place by a center stud and nut. Adaptation of the Dual Voltage Switch to different line voltages is simple and fast. The center nut is loosened and the top cover is rotated until the desired line voltage figures are visible, no other adjustment.

The Standard Dual Voltage Switch is designed for 220–440 volts of a delta connected motor—the type used on Wilson Welders. Other connections, such as 220–440 volts of Y connected motor and of Y delta connection (380/220) are all readily obtainable.

New Small Tournapull

COMBINING SPEED, power, and average capacity, R. G. LeTourneau, Inc. has developed its third and smallest Tournapull, Model C, for long haul dirt moving.

Powered by a "Caterpillar" four cycle, six cylinder D-468 Diesel engine, it has a top speed of 13 to 15 mph, and at 1800 rpm develops a maximum brake hp of 90. Two different size tires are available for the Model C Tournapull to meet job requirements, 21 × 24 and 18 × 24. To give maximum traction the entire weight of the engine and half of the weight of the Carryall Scraper and its load are placed on the two large pneumatic tired drive wheels. Steering is accomplished by independent operation of the two drive wheels, each controlled by a slow-speed, heavy duty, double cone clutch, using a metal lining running in oil.

Mated to the Model C Tournapull is the Model LS Carryall Scraper, with a struck capacity of 8.2 cu yds and a heaped of 11. Features, such as the crescent arch "A" frame, larger apron and traveling sheaves controlling apron are all incorporated in this Carryall. The Tournapull and Carryall combination is a self-loading unit. However, to get the maximum operating efficiency, reduced loading time and increased pay yards pusher loading is recommended. Being a self-loading and self-spreading unit, it is claimed that the economies of tractor-scraper operation are extended to truck haul jobs.

The Model C is the third Tournapull size now available to earthmovers. The first Tournapull introduced was the Model A. Powered by a D-1700 "Caterpillar" Diesel it operates with either NU, 45-yd; N, 33-yd; or RU, 30-yd Carryall Scrapers or a 30-yd Tournatrailer.

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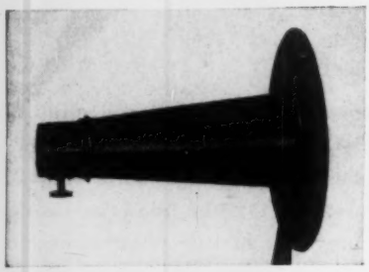

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Literature of new model polariscope now available.

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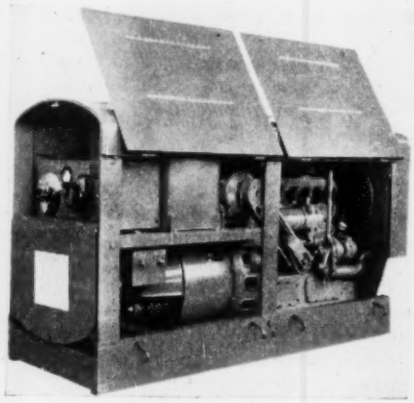
400-Amp Diesel Arc Welder

THE APPLICATION of gasoline engine starting on Diesel driven arc welders, announced previously on a 300-amp unit by The Lincoln Electric Co., Cleveland, Ohio, has been extended to include a 400-amp model.

According to reports, the Diesel welder cuts fuel costs 33% to 86%, with total savings as high as 40¢ per hr. The gasoline starting engine is a small auxiliary mounted above the Diesel, and is started by means of a hand crank. A belt drive, engaged by means of a clutch, connects the starting engine to the Diesel. Starting in extremely cold weather is facilitated by having the cooling system of the small starting engine connected into the cooling system of the Diesel.



Of 400-amp capacity, the "Shield Arc SAE" arc welding generator used on the new Diesel welder is equipped with "dual continuous control," other features are: extra wide welding range; independent excitation; laminated magnetic circuit; high capacity; high efficiency; cool operation; all-purpose meter; and arc welded steel drip-proof construction.

New 1 Yard Shovel

A NEW, POWERFUL 1 to 1¼ yd convertible shovel-dragline-crane, Model LS-100, is announced by Link-Belt Speeder Corp., 301 West Pershing Road, Chicago, Ill.

The machine is controlled by easy-throw levers and equipped with a new type of clutch, said to produce results not before attained by friction clutches. Further features are: fully enclosed travel brakes controlled from cab; fully enclosed traction gears running in oil; a 72 in. diam. machine-finished roller-path turntable with patented, self-aligning rollers; anti-friction bearings throughout; free floating center-pin bearings; and welded steel design for strength and resistance to shock loads and to provide positive alignment of machinery parts. The engine is a heavy-duty industrial type; gasoline or Diesel. Track shoes are 24 in. standard (30 in. optional); crawlers are smooth, self-cleaning and perfect guiding.

The machine may be quickly converted from one excavating or handling attachment to another, without mechanical alteration. Complete details of the LS-100 may be obtained from the manufacturer.

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